Digitized by the Internet Archive
in 2019 with funding from
Wellcome Library

https://archive.org/details/s3id13528620

PHILOSOPHICAL

TRANSACTIONS

OF THE

ROYAL SOCIETY

OF

LONDON.

FOR THE YEAR MDCCCXXVI.

PART III.

LONDON:

PRINTED BY W. NICOL, SUCCESSOR TO W. BULMER AND CO.
CLEVELAND-ROW, ST JAMES'S;
AND SOLD BY G. AND W. NICOL, PALL-MALL, PRINTERS TO THE ROYAL SOCIETY.

MDCCCXXVI.

CONTENTS.

XIV. *On the coagulation by heat of the fluid blood in an aneurismal tumour. By Sir* EVERARD HOME, *Bart. V. P. R. S. Communicated January* 23, 1826. - - page 189

XV. *On the mathematical theory of suspension bridges, with tables for facilitating their construction. By* DAVIES GILBERT, *Esq. V. P. R. S. &c. Communicated March* 9, 1826. 202

XVI. *On magnetic influence in the solar rays. By* SAMUEL HUNTER CHRISTIE, *Esq. M. A. F. R. S. of Trinity College, Cambridge; Fellow of the Cambridge Philosophical Society: of the Royal Military Academy. Communicated November* 15, 1825. - - - - - 219

XVII. *On the mutual action of sulphuric acid and alcohol, with observations on the composition and properties of the resulting compound. By Mr.* HENRY HENNELL, *chemical operator at Apothecaries' Hall. Communicated by* W. T. BRANDE, *Esq. Sec. R. S.* - - - - 240

XVIII. *On a method of expressing by signs the action of machinery. By* CHARLES BABBAGE, *Esq. F. R. S. Communicated January* 17, 1826. - - - 250

XIX. *On the parallax of the fixed stars. By* J. F. W. HERSCHEL, *Esq. M. A. Sec. R. S. Communicated January* 19, 1826. 266

XX. *A formula for expressing the decrement of human life. In a letter addressed to Sir* EDWARD HYDE EAST, *Bart. M. P. F. R. S. By* THOMAS YOUNG, *M. D. For. Sec. R. S. Communicated February* 2, 1826. - - - 281

XXI. *Account of an experiment on the elasticity of ice. By* BENJAMIN BEVAN, *Esq. In a Letter to Dr.* THOMAS YOUNG, *For. Sec. R. S.* - - - - 304

XXII. *Results of the application of Captain* KATER'S *floating collimator to the astronomical circle at the observatory of Trinity College, Dublin, and remarks relative to those results. By the Rev.* J. BRINKLEY, *D.D. F. R. S P. R. I. A. Communicated by the Board of Longitude February* 2, 1826. - 307

XXIII. *On the means of facilitating the observation of distant stations in geodætical operations. By Lieutenant* THOMAS DRUMMOND, *of the Royal Engineers. Communicated April* 14, 1826, *by Lieut. Col.* H. COLBY, *F. R. S.* - 324

XXIV. *On the production and formation of pearls. By Sir* EVERARD HOME, *Bart. V. P. R. S.* - - 338

XXV. *On burrowing and boring marine animals. By* EDWARD OSLER, *Esq. Communicated February* 15, 1826, *by* L. W. DYLLWIN, *Esq. F. R. S.* - - - 342

XXVI. *An account of some experiments relative to the passage of radiant heat through glass screens. By the Rev.* BADEN POWELL, *M. A. F. R. S. of Oriel College, Oxford. Communicated March* 9, 1826. - - - 372

XXVII *The Bakerian Lecture. On the relations of electrical and chemical changes. By Sir* HUMPHRY DAVY, *Bart. Pres. R. S.* - - - - - 383

XXVIII. *On the discordances between the Sun's observed and computed Right Ascensions, as determined at the Blackman-street Observatory, in the years* 1821 *and* 1822; *with Experiments to show that they did not originate in instrumental derangement. Also a description of the seven-feet Transit with which the observations were procured, and upon which the experiments were made. By* James South, *Esq. F. R. S. Communicated June* 1, 1826. - - - - 423

XXIX. *On the existence of a limit to vaporization. By* M. Faraday, *F. R. S. Corresponding Member of the Royal Academy of Sciences at Paris, &c. Communicated May* 26, 1826. - - - - 484

XXX. *On electrical and magnetic rotations. By* Charles Babbage, *Esq. F.R.S. &c. Communicated May* 29, 1826. 494

XXXI. *Case of a lady born blind, who received sight at an advanced age by the formation of an artificial pupil. By* James Wardrop, *Esq. F. R. S. Edin. Surgeon Extraordinary to the King, &c. Communicated by the President.* - 529

XXXII. *On the progressive compression of water by high degrees of force, with some trials of its effects on other fluids. By* J. Perkins. *Communicated by* W. H. Wollaston, *M. D. V.P.R.S. May* 25. - - - 541

XXXIII. *On the figure of the earth. By* George Biddell Airy, *M. A. Fellow of Trinity College, Cambridge. Communicated by* J. F. W. Herschel, *Esq. Sec. R. S.* 548

APPENDIX.

Presents received by the Royal Society from 17th November 1825, to 15th June 1826.

Index.

Meteorological Journal kept at the Apartments of the Royal Society, by Order of the President and Council.

PHILOSOPHICAL

TRANSACTIONS.

XIV. *On the coagulation by heat of the fluid blood in an aneurismal tumour. By Sir* EVERARD HOME, *Bart. V. P. R. S. Communicated January* 23, 1826.

Read March 2, 1826.

In a case of aneurism in the external iliac artery, in Chelsea Hospital, for the cure of which I tied the femoral artery below the sac, on the 16th September 1825; upon finding that this operation neither diminished the pulsation, nor arrested the increase of the size of the tumour, I was led to introduce a needle, to which is given the name of acu punctorium, into the centre of the tumour where the pulsation was most violent, and the fluid state of the blood most distinctly felt: the needle was passed through a small orifice in a bar of steel three inches long, the skin of the thigh was guarded by cork, and the needle was heated through the medium of the steel by a spirit lamp. In a few minutes the patient felt heat and pain in the centre of the tumour, but not very severe, so that the application was continued for fifteen minutes, during which the pulsation in the tumour was diminished; on withdrawing the needle the

orifice was marked by a single drop of coloured serum. In half an hour intense pain was felt in the thigh; but this was not only removed in ten minutes by 20 drops of laudanum, but the thigh and leg became more easy than they had been for the previous twelve hours, and the throbbing in the sac was reduced to an undulation.

This application of heat was not resorted to till the 28th day after taking up the femoral artery, in which time the swelling had increased in size very considerably. The man was 43 years of age, had served 18 years in the 14th dragoon guards, and was a hard drinker. For two days the tumour was easy, and the pulsation had become less under the punctured part than higher up towards the belly. The tumour not diminishing, the operation was repeated on the 34th day from tying the artery; the needle and bar of steel double the size of those before used, and the application continued 35 minutes. The internal heat was greater than before, and the pulsation in the tumour much diminished. The needle was with difficulty withdrawn, a coagulum as hard as sealing-wax the size of a pin's head being firmly attached to the middle of the needle. The pain the operation produced subsided in ten minutes; the internal heat continued 24 hours, and the tumour had now a solid feel: he was quite easy for two days, but on the third the pain and pulsation returned, also the inward pain in a still greater degree than while the needle was immersed, and the tumour was extremely tense. Under these circumstances, on the 44th day after tying the femoral artery, I repeated the application of the acu punctorium with a needle and steel double the size of those last employed: the heat felt internally was very great, but the

pain was not much increased: after it had been immersed 20 minutes the pulsation all at once stopped, and the needle was immediately withdrawn; the pain in ten minutes went off, and the patient was quite easy. From this time there was no pulsation in the tumour, which to the feel appeared solid, and therefore I considered the progress of the aneurism arrested; this was in some measure proved by the pulsation remaining violent in the external iliac artery down to the part pressed upon by the sac, but no further.

Although the patient was free from pain, took his usual allowance of food, and relished his wine and porter as much as before, the foot about the 50th day became cold to the touch, the thigh and leg œdematous, and about the 60th day vesications made their appearance on the foot and leg; the skin lost its sensibility, and although he had little or no pain, the weight of the thigh took from him all power of moving it.

These symptoms were the forerunners of mortification, the pressure from the tumour above preventing the leg from receiving a sufficient supply of nourishment; they did not however increase, and he remained in nearly the same state till the 90th day, when he died.

The upper part of the thigh, which had been regularly measured, was found on the 44th day to be 24 inches, and remained of the same size at his death, three inches and an half beyond that of the other.

On the examination of the parts after death, the external iliac artery was found to pass down in the front of the aneurismal sac; it was pervious in its course to the part where the ligature had been made on the femoral trunk; there it

was plugged up by a small coagulum, beyond which it was impervious. The opening into the sac was on the posterior part, and was one inch in length. The coagulum formed by the heated needle had so unusual an appearance and texture, that it is shown in the annexed drawing. The upper portion of the sac occupied a part of the cavity of the pelvis, and by its pressure prevented the branches of the internal iliac artery from supplying the thigh with blood.

The coagulum in contact with the sac was the same as is usually met with in large aneurismal tumours; within that there were innumerable thin firm lamina, and the innermost portion was in the state of jelly.

It is a circumstance which could not have been foreseen, but one highly satisfactory to myself, that had I attempted to tie the artery above the formation of the aneurismal sac, I must have failed, since the sac extended higher than the division of the iliac artery into the external and internal, so that the external branch could not be secured without wounding the sac, which would have proved fatal; and in the space above, between the division into two iliacs, and the bifurcation of the aorta, there is an ossification an inch long; so that if the artery had been secured there, when the ligature separated, the patient must have bled to death. It may be said, that I might have taken up the aorta above the bifurcation; but I have made up my mind to let those diseases that require tying the aorta, which come under my care, take their course.

From the ossifications met with on the arterial trunks so much nearer the heart than the aneurismal sac, and a similar ossification having been formed in the femoral artery in the

middle of the thigh, where it was taken up by Mr. HUNTER in the first instance in which he performed that operation for the cure of popliteal aneurism, we learn that in those individuals liable to aneurism, the larger trunks are more disposed to ossification than common, and therefore the tying such trunks is attended with no inconsiderable risk of hæmorrhage when the ligature comes away.

From the present case of aneurism, and Mr. HUNTER's, in which the success was complete, we find the contents of the sac are less readily absorbed than was believed. In proof of this, I have annexed a drawing of the natural size, taken from the remaining tumour of the popliteal artery of the patient on whom Mr. HUNTER first took up the femoral artery for the cure of aneurism in the ham, in the year 1785. The patient died of a fever 20 months after the operation, which afforded an opportunity of ascertaining the slow progress that had been made in the absorption of the contents of the aneurismal sac.*

From the statement that has been given, I trust that I have fully proved that the heated acu punctorium can coagulate the fluid blood contained in the aneurismal sac; and in doing so, is not productive of any local or constitutional symptoms that should prevent its being employed for that purpose.

* Vide Trans. of a Society for Promoting Med. and Chirurg. Knowledge, vol. i. p. 138.

EXPLANATION OF THE PLATES.

PLATE III. An anterior view of the aneurismal sac.

Fig. 1. A small portion of the aorta; the division into the two iliac arteries. The sub-division into the external and internal branches. The external iliac artery traced along its course to the opening into the sac. The upper part of the femoral artery slit open, from the lower orifice in the sac to the part where it became obliterated by the coming away of the ligature.

Fig. 2. The lower part of the aorta slit open; also the common trunk of the iliac artery, to show that the internal membranes of both have begun to ossify. The figures are of the natural size.

PLATE IV. An internal view of the aneurismal sac.

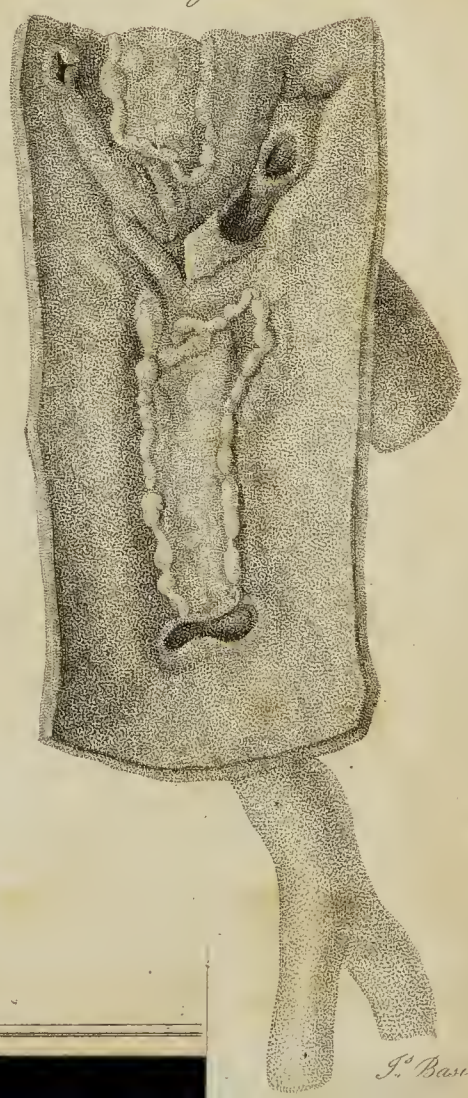
Fig. 1. The aorta and external iliac passing on the outside of the aneurismal sac. The lamina of the coagulum first formed, and resembling those met with in other aneurismal tumours. The opening into the arterial trunk from the coats having given way for the space of one inch, exposing the upper and lower orifice of the artery; and showing that the sac adhered to the artery even higher than the going off of the internal iliac.

Fig. 2. A small portion of the blood coagulated by the heated needle, which has a foliated structure, the leaves thin, compact, and connected together by thread-like filaments. Both these figures of the natural size.

Fig. 3. One of these leaves magnified ten diameters; its surface studded over with nodules of coagulable lymph, like so many drops of melted wax.

Fig. 1.

Fig. 2.



J. Basire, sc.

Fig. 3.

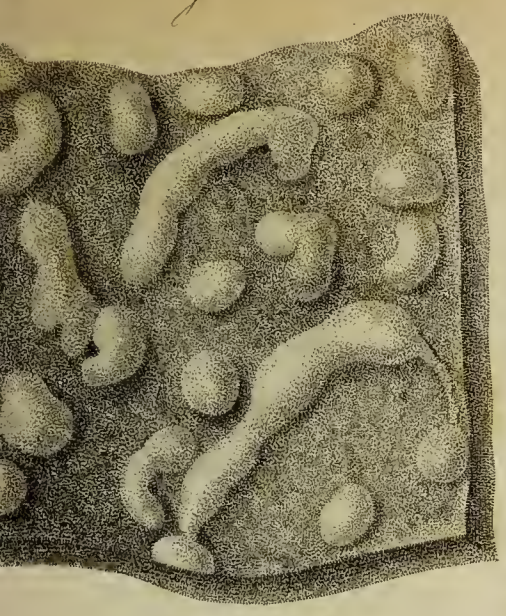


Fig. 2.

Fig. 1.

Fig. 1.

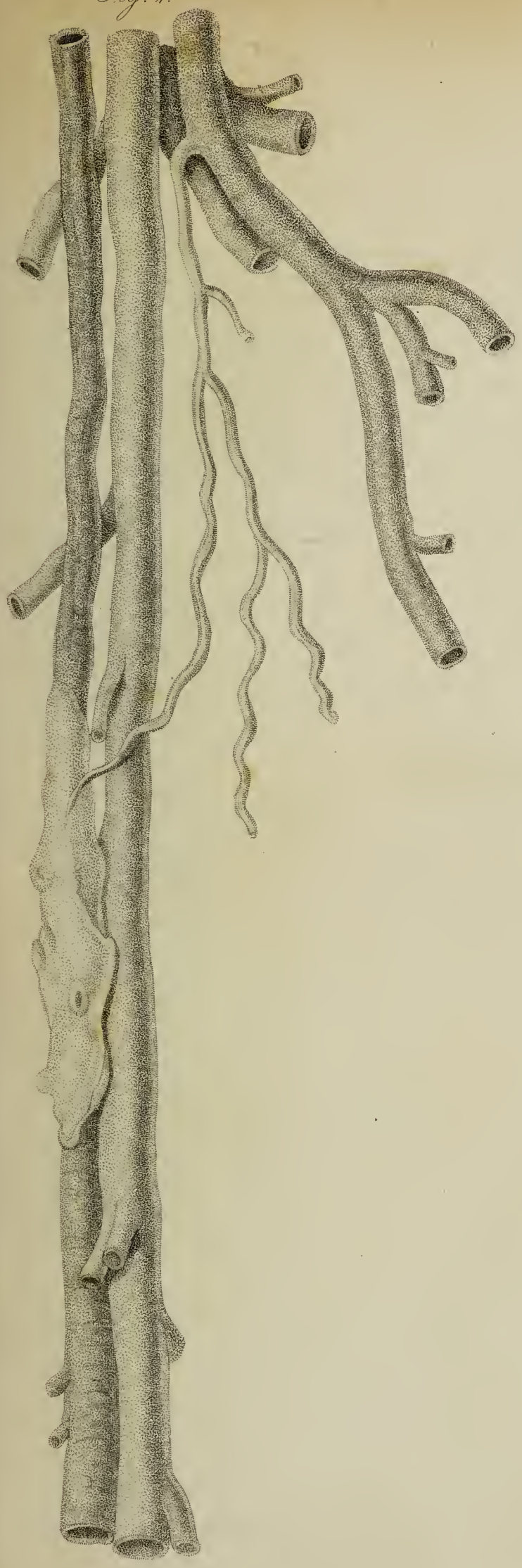


Fig. 2.

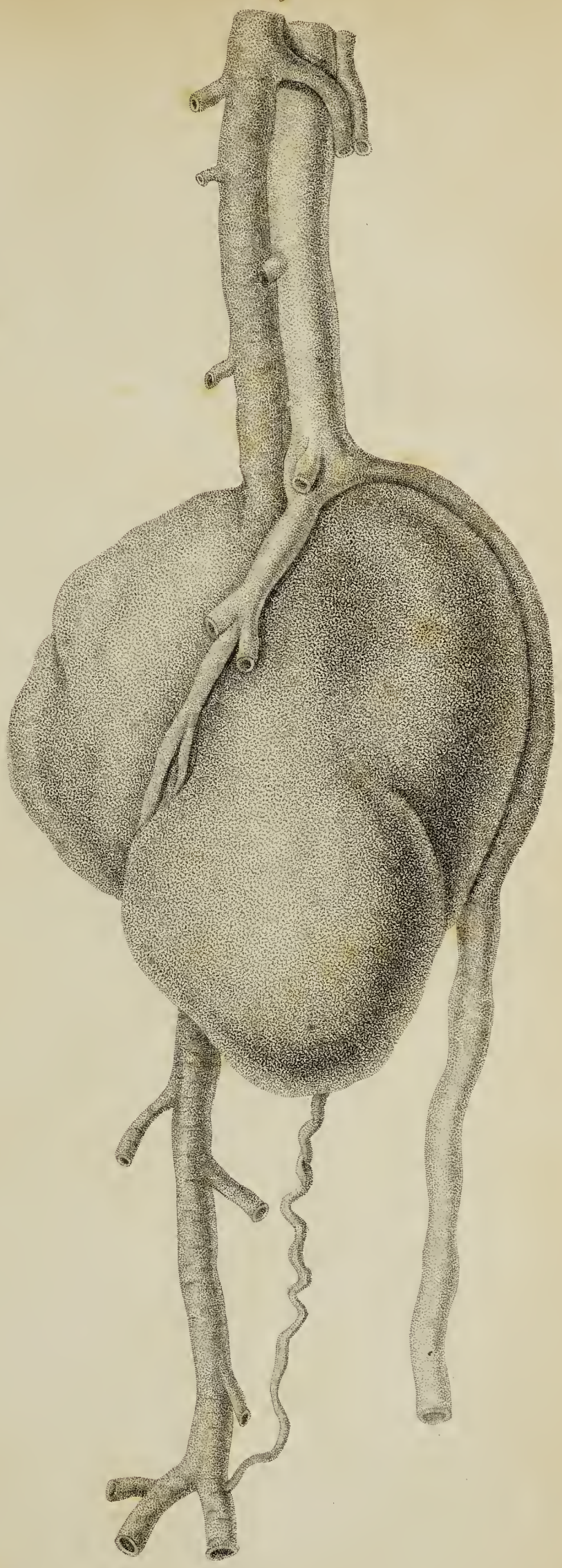


Plate V.

A representation of the appearance of the remains of the tumour twenty months after the femoral artery had been tied by Mr. Hunter, in the first case in which he performed that operation for the cure of popliteal aneurism, in the year 1785, at St. George's Hospital. The case was published in 1793, in the first volume of the Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge, but no engraving accompanied that account. That now given is taken from the parts removed from the body after death, which are rendered distinct by having been injected.

Fig. 1. Shows the femoral artery, the canal of which had been rendered impervious from the going off of the large muscular branch called profunda, down to where the ligature had been tied, and there it was ossified. Below this it retained its natural size. There is a small branch from the arteria profunda anastomosing with the femoral trunk immediately below the impervious portion, at the part where the coats afterwards became ossified. The femoral vein accompanies the artery.

Fig. 2. represents the continuation of the femoral artery, showing the dilatation into the aneurismal sac; the size of which is much greater than could have been expected had the absorption gone on with the same activity as in naturally formed parts, 20 months, after the disease had been put a stop to.

Below the aneurismal tumour is a large anastomosing branch from the profunda, with the trunk of the popliteal artery before its division. The veins are spread over the tumour.

On the effect of heated iron upon fluid blood out of the body.

That I might ascertain the effect of heated iron immediately after it was applied to fluid blood, I bored a hole in the centre of the bottom of a horn cup, through which the same acu punctorium used in the case of aneurism was passed up into the middle of the vessel; and when it was heated by the same bar of iron and spirit lamp, three ounces of blood were received from the arm into the cup, and the heat continued for half an hour, after which the blood was left at rest for 24 hours.

The coagulum had no buff on the surface. When a perpendicular section was made of it, the mass of the red coagulum was interspersed with minute white particles of coagulable lymph, and that part in contact with the needle, for the space of half an inch round, was in the same state as is represented in the drawing of the aneurismal coagulum. To carry on this investigation with pieces of iron, the heat of which was ascertained, I made the following experiment: three pieces of iron, weighing an ounce each, with iron handles covered with wood, were placed in separate cups, and blood from the arm immediately received into them to the amount of three ounces. In the first, the iron was red hot, in the second, the red colour had just gone off, and the third was taken out of boiling water. In five minutes the heat of each portion of blood was ascertained by the thermometer, the pieces of iron being removed. No. 1. was 110°, No. 2. 105°, No. 3. 85°, the atmosphere 55°. After standing 24 hours, perpendicular sections were made of them.

No. 1. had separated seven drams of serum, had a greyish film $\frac{1}{40}$th of an inch thick; the coagulum was coloured, loose in its texture, interspersed with specks of white coagulable lymph; and at the lower part there was a cell, the shape of the piece of iron, the sides of which had the same frosted floculent appearance seen in the drawing of the aneurism. No. 2. had separated 12 drams of serum, had a film $\frac{1}{20}$ of an inch thick, the coagulum was more solid, coloured, interspersed with specks of coagulable lymph, and had a cell in all respects like that in No. 1.

No. 3. had separated 12 drams of serum, had a buffy coat, much cupped, $\frac{1}{8}$ of an inch thick; the coloured coagulum very solid, and no cavity was found where the iron had been situated.

To determine the effect of lower temperature, I made a similar experiment with three leaden ounce balls, 1st heated to 200°, 2d to 160°, 3d to 120°. At the end of 24 hours, the balls having been left in the cups, No. 1. had a film of buff $\frac{1}{20}$th part of an inch, separated 4 drams of serum, round the cavity surrounding the ball a film $\frac{1}{40}$th of an inch. No. 2. had a film $\frac{1}{24}$th of an inch, serum $6\frac{3}{4}$ drams, round the ball no film. No. 3. buffy and cupped, the buff $\frac{1}{16}$th of an inch, whiter and tougher than the other. The overplus blood drawn into a porringer not in the least buffy.

From these experiments, blood is rendered buffy at the top by a heat of 120°, and when poured on substances heated above 212° the coagulable lymph is separated where it comes in contact with the heated body.

It is a fact ascertained, that when blood is drawn from the arm into a cup immersed in boiling water, which is kept for

some hours at that heat, does not form a complete coagulum; but if drawn into a cup immersed in ice and left there, in 24 hours I found the surface had a buffy coat $\frac{3}{8}$ of an inch thick; and although 5 drams of serum had separated, the coagulum was so loose as hardly to hold together.

A new fact respecting buffy blood after venesection.

It has been generally believed that the cupped appearance met with on the surface of the coagulation of blood drawn from the arm, arises from the coagulable lymph, when separated from the other parts of the blood, having a greater contractile power than when intimately mixed with them.

In a patient who had an affection of the brain in consequence of an injury to the skull from a wooden shovel, when 35 years of age, no symptoms came on for 8 months. He then had fits, and head-ache, which nothing relieved: he was bled to the amount of 68 oz. in 13 days; but the last two cups, although equally buffy with all the others, were not cupped, which took my attention. The appearance is shown in the annexed drawing, proving that the coagulable lymph has less power of contraction than the other parts of the blood.

The malady was found, by examining the body after death, to be inflammation of one of the convolutions of the right hemisphere of the cerebrum.

In the microscope, the upper portion without colour consisted wholly of globules $\frac{1}{2,800}$ and $\frac{1}{3,200}$ parts of an inch in diameter; the lower coloured portion was entirely made up of globules $\frac{1}{2,000}$ and $\frac{1}{2,400}$ parts of an inch in diameter.

Professor Brande, who examined the chemical properties of these different portions, informs me, "that the upper por-
"tion had the usual properties of the albumen of the blood.
"When carefully dried, it assumed the appearance and che-

" mical characters of horn. The lower coloured portion was " looser in texture and considerably softer. In dilute acetic " acid it soon became perfectly gelatinous, and was dissolved " in it by the aid of a gentle heat. It contained a much " larger relative proportion of water than the upper portion, " and shrunk much more when dried, in which state, however, " it resembled dried albumen. It appears that independent " of colouring matter, these two portions of coagulum differ " chiefly from each other in their state of concentration, the " upper part containing more albumen, and less water, than " the lower."

EXPLANATION OF PLATE VI.

Fig. 1. The coagulum represented entire. While immersed in the serum the surface was flat, but after remaining a few hours in weak spirit to prevent it from falling to pieces, the surface put on its present appearance.

Fig. 2. A perpendicular section of the same coagulum. Both of these figures are of the natural size.

Fig. 3. A small part of the upper portion of fig. 1. magnified 200 diameters, to show the size of the globules of which it was composed to be from $\frac{1}{2800}$ to $\frac{1}{3,200}$ parts of an inch in diameter.

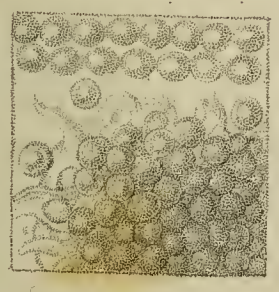
Fig. 4. A small part of the lower portion, fig. 2. magnified 200 diameters; showing the size of the globules it contained to be from $\frac{1}{2,000}$ to $\frac{1}{2,420}$ parts of an inch in diameter, mixed with a coloured gelatinous substance.

Fig. 5. A coagulum of blood taken from the arm of a person labouring under symptoms of inflammation of the

Fig. 1.

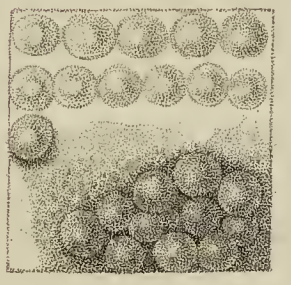
Fig. 2.

Fig. 3.



From 2800 to 3200 parts of an inch.

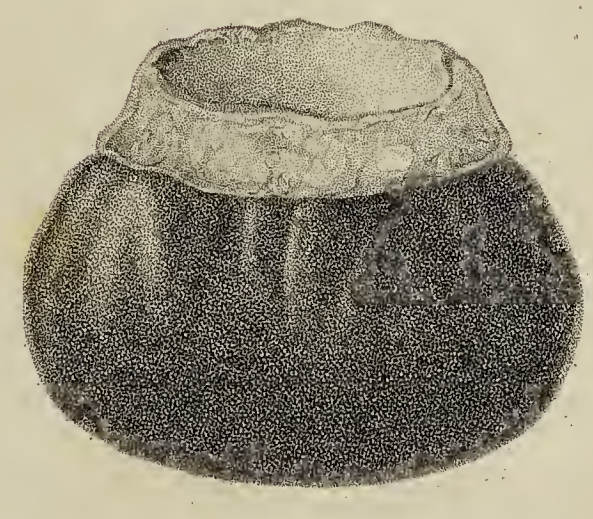
Fig. 4.



From 2000 to 2400 parts of an inch.

Fig. 5.

Fig. 6.



lungs; the upper surface is concave; and the coagulable lymph of which it is composed is not entirely free from an admixture of the other component parts of the blood.

Fig. 6. A perpendicular section of fig. 5. The two last figures are represented of their natural size.

XV. *On the mathematical theory of suspension bridges, with tables for facilitating their construction. By* DAVIES GILBERT, *Esq. V.P.R.S. &c. Communicated March* 9, 1826.

Read March 9, 1826.

MY attention was first directed to a consideration of suspension bridges, and of the catenary curve on which their theory depends, when the plan for making such a communication across the Menai Straits was submitted to the Commissioners appointed by Parliament to improve the communication by roads and bridges through Wales. It then appeared to me, that the proposed depth of curvature, was not sufficient for ensuring such a degree of strength and permanence as would be consistent with the due execution of a great national work. This opinion I advanced as a Member of the Commission. But wishing to take on myself the full responsibility for such increased expense, as must of necessity be occasioned by enlarging the curvature, I also printed some approximations, hastily deduced, in the Quarterly Journal of Science; and derived from them a confirmation of the opinion that had been given. The interval between the points of support and the road-way of the Menai Bridge has in consequence been augmented to fifty feet; and it now possesses that full measure of strength, which experience has established as requisite and sufficient for works of iron not perfectly at rest.

Since bridges of suspension are obviously adapted to very general use, I have flattered myself with the hope of doing something serviceable to the public, by expanding into tables

the formulæ from which my approximations were derived; adding to them other formulæ and tables for the catenary of equal strength. A curve not merely of speculative curiosity, but of practical use, where a wide horizontal extent may chance to be combined with natural facilities for obtaining a correspondent height for the attachments.

Both the ordinary catenaries, and these of equal strength, like circles, parabolas, logarithmic curves, &c. have the property of being each identical with themselves in every respect but size: and as the radius, the parameter, and the subtangent give the respective magnitudes of these curves, so are the catenaries determined in magnitude by the tension (expressed in measures of the chain), which takes place at the middle point, or apex of the curve, where it is a minimum. Consequently, when this tension is determined or given, all the other relations may be expressed in the same manner as sines, cosines, &c. in the circle.

I assume that the first principles of the catenary curve are known; they will, consequently, be noted with no other view, than to derive from them ulterior properties.

For the ordinary catenary:

Let $a =$ the tension at the apex, estimated in measures of the chain;

$x =$ the absciss, the versed sine, or depth of curvature;

$y =$ the ordinate, or semi-transverse length;

$z =$ the length of the curve.

Then since the tension, (a,) acts horizontally at the apex (A,) since the weight of the chain (z) acts at right angles to the former, and the force of suspension at (P) acts in the direction of the tangent. These forces must be represented in direc-

tion and in magnitude by the incremental triangle P*r p*; and

As $\dot{x} : \dot{y} :: z : a$; as $\dot{x}^2 : \dot{y}^2 :: z^2 : a^2$;

as $\dot{x}^2 + \dot{y}^2 : \dot{x}^2 :: a^2 + z^2 : z^2$;

But $\dot{x}^2 + \dot{y}^2 = \dot{z}^2$ universally.

Therefore, $\dot{z}^2 : \dot{x}^2 :: a^2 + z^2 : z^2$; and $\dot{x} = \frac{z\dot{z}}{\sqrt{a^2 + z^2}}$; consequently, $x = \sqrt{a^2 + z^2} - a$.

Equation A
- No. 1. $x = \sqrt{a^2 + z^2} - a$
- No. 2. $z = \sqrt{2ax + x^2}$
- No. 3. $a = \frac{z^2 - x^2}{2x}$

Again; $\dot{x} : \dot{y} :: z : a \therefore \dot{y} = \frac{a\dot{x}}{z}$, substituting from Eq. A. (No. 2.

$\dot{y} = \frac{a\dot{x}}{\sqrt{2ax + x^2}}$; and

Equ. B. No. 1.) $y = a \times$ natural log. of $\frac{a + x + \sqrt{2ax + x^2}}{a} =$ $a \times$ nat. log. $\frac{a + x + z}{a}$; or by substituting its value for a from Equ. A. No. 3, and dividing by $z + x$.

Equ. B. No. 2.) $y = a \times$ nat. log. $\frac{z + x}{z - x}$;

or, if $\frac{z\dot{z}}{\sqrt{a^2 + z^2}}$ be substituted for $\dot{x}$ in

$$\dot{y} = \frac{a\dot{x}}{z}. \quad \dot{y} = a \times \frac{\dot{z}}{\sqrt{a^2 + z^2}}$$

and

Equ. B. No. 3.) $y = a \times$ nat. log. $\frac{\sqrt{a^2 + z^2} + z}{a}$.

To find x when a and y are given:

Let N = the number of which $\frac{y}{a}$ (Equ. B. No. 1.) is the natural logarithm.

Then $a\,\mathrm{N} = a + x + \sqrt{2ax + x^2}$, and $\sqrt{2ax + x^2} = a\,\mathrm{N} - a - x$, make $a\,\mathrm{N} - a = \mathrm{M}$. Then $2ax + x^2 = \mathrm{M}^2 - 2\,\mathrm{M}x + x^2$, and

Equ. C.) $x = \frac{\mathrm{M}^2}{2\mathrm{M} + 2a}$,

x being known.

z is found from Equ. A. No. 2. and

T, the tension at P, being obviously equal to $\sqrt{a^2 + z^2}$, is equal (Eq. A. No. 2.) to $\sqrt{a^2 + 2ax + x^2} = a + x$.

The angle of suspension is derived from the common analogy of the incremental triangle, and of the forces corresponding with it.

Tables I. and II. are constructed from these theorems, and their use will be best explained by an example.

Let the span proposed for a suspension bridge be 800 feet, and let the adjunct weight of suspension rods, road-way, &c. be taken at one-half of the weight of the chains; then, if the full tenacity of iron is represented by the modulus of 14800 feet, the virtual modulus for the whole weight must be reduced in the proportion of $2 + 1 : 2$, or to 9867 feet; and let it be determined to load the chains at the point of their greatest strain, that is at the points of suspensions, with one-sixth part of the weight they are theoretically capable of sustaining.

Then, since the semi-span is 400 feet, and y in Table I. is taken at an hundred measures, each of these measures must be four feet, and the weight expressed in the same measures to be sustained at the points of suspension will be $9867 \div 6 \times 4 = 411{,}125$. Now it appears from Table I. where y is uniformly an hundred, that when $T = 412$

$a = 400$ measures or 1600 feet.

$x = 12.565$ - - 50.260

$z = 101.045$ - 404.180

$<$ the angle of suspension $75^\circ\ 49'$.

Having now determined a, the modulus, latus rectum, or parameter of the curve. In Table II. will be found all the respective quantities for each measure of y. But as a is in

this table taken at an hundred measures, and it has been found to be 400 of the former, each measure here must be 4 times 4, or 16 feet; consequently, each gradation of y will also be 16 feet, and the whole semi-span $\frac{400}{16}$ or 25 measures. And since z will be given in the Table for each measure of y, the adjunct weights may readily be adapted to a strict preservation of the catenary form.

At 21 measures of y . z = 21.1547
20 measures of y . z = 20.1335

1.0212 × 16 = 16.3392 feet.

Consequently while the ordinate extends one measure, or 16 feet from the 20th to the 21st measure, the length of the curve will increase 16 feet and $\frac{1}{3}$ very nearly, and the adjunct weight should be increased in the same proportion.

At 21 the length of x is 2,2131 measures, or multiplied by 16 = 35,4096 feet, the length of the suspension rods to the level of the apex.

It appears from Table I. that the tension T for a given half span of 100 measures is very nearly at its minimum when x = 65,85 measures, almost one-third part of the whole span. In the example taken above 65.85 × 4 = 263,4 feet, an height not to be attained in practice, nor strictly upplicable if it could be reached, because of the great length of suspension. If the span and height ($2y$ and x) were given, the other quantities would be found in a similar manner.

In the catenary of equal strength

a . x . y . z remain as before; but another symbol must now be introduced, ζ = the mass of the chain. Then will the

forces be represented as in the ordinary curve by the incremental triangle P*rp*. But now $\dot{x} : \dot{y} :: \zeta : a$. And by a repetition of the former steps $\dot{x} = \frac{\zeta \dot{z}}{\sqrt{a^2 + \zeta^2}}$.

But on the principle of equal strength,

As $a : \sqrt{a^2 + \zeta^2} :: \dot{z} : \dot{\zeta}$

therefore $\dot{z} = a \times \frac{\dot{\zeta}}{\sqrt{a^2 + \zeta^2}}$ and

Equ. D.) $z = a \times$ nat. log. $\frac{\sqrt{a^2 + \zeta^2} + \zeta}{a}$;

and by substituting $a \times \frac{\dot{\zeta}}{\sqrt{a^2 + \zeta^2}}$ for $\dot{z}$ in the equation $\dot{x} = \frac{\zeta \dot{z}}{\sqrt{a^2 + \zeta^2}}$

$\dot{x} = a \times \frac{\zeta \dot{\zeta}}{a^2 + \zeta^2}$; consequently,

Equ. E.) $x = \frac{a}{2} \times$ nat. log. $\frac{a^2 + \zeta^2}{a^2}$.

Again, from the first analogy, $\dot{y} = \frac{a \dot{z}}{\zeta}$,

substitute for $\dot{x}$ its equal $a \times \frac{\zeta \dot{\zeta}}{a^2 + \zeta^2}$, and

$\dot{y} = a^2 \times \frac{\dot{\zeta}}{a^2 + \zeta^2}$; therefore,

Equ. F.) $y =$ the cir. arc. of which ζ is the tangent to radius a.

a and y being given to find ζ. Multiply $\frac{y}{a}$ by 57°,29578 (the tab. log. 1.7581226) and reduce the decimals of a degree into minutes and seconds; then will the tangent of that arc, multiplied by a, be equal to ζ.

And when ζ has been determined, the other columns of Tables III. and IV. are constructed from the above theorems, in a manner perfectly similar to that used in calculating of Tables I. and II.; and they may be illustrated by the same example; observing that a, now represents the uniform tension on each given magnitude of iron throughout the chains,

and that the column T has the whole pull which any building or support may have to sustain in the direction of the tangent.

In Table III. y being, as before, an hundred measures of four feet each, a must be sought $=411{,}125$, and by proportioning between 420 and 400

$x=$ 12.2904	- - - -	49.1616	Feet.
$z=$ 101.0020	- - - -	404.0080	
$\zeta=$ 102.0235	measures or - - - -	408.0940	
T $=$ 423.6019	- - - -	1694.4076	

$< . 76^\circ\ 3'\ 17''$.

a, or the modulus of this curve being fixed at 411,125 measures of 4 feet each, or at 1644,5 feet; and a in Table IV. being taken at 100 measures, each one will be 16,445 feet, and all the quantities are given for each gradation of y.

Thus at 21 measures of y . $z=21.1564$ $\zeta=21.3142$

20 measures of y . $z=20.1347$ $\zeta=20.2710$

1,0217 1.04332

$1.0217 \times 16.445 = 16.8019$ feet the increase of z;

$1.0432 \times 16.445 = 17.1410$ feet the increase of material in ζ: consequently $\frac{1.0432}{1.0217} = 1.021$, the quantity of matter in this part of the chain to maintain uniform strength, that at the apex being unity, and the adjunct matter should be in the proportion of 1 to 1,04332.

Moreover x the versed sine, or the length of the suspension rods to the level of the apex will be at

21 measures of y . $x=2.2214$ measures $\times$ 16,445 $=36{,}531$ ft.

20 measures of y . $x=2.0135$ measures $\times$ 16.445 $=33.112$ ft.

Assuming in the ordinary catenary that $x = 65.85$ measures, is the height of the attachment to give a maximum extent of span with any virtual tenacity of material, a will be 85 measures, and $a + x = 85 + 65.85$, or 150,85 measures equal the given virtual tenacity. This taken as before at $\frac{2}{3}$ of $\frac{1}{6}$ of 14800 feet, will give 10,875 feet for each measure, and the whole span at $2y = 2175$ feet. Chains merely supporting themselves, and at the utmost of their tenacity will extend nine times further, or to 19575 feet.

In the catenary of equal strength, the semi-span being equal to the circular arc of which ζ is the tangent to radius a, it is obvious that $a \times$ semi-cir. arc must be the limit of the span. Therefore if $a = \frac{2}{3}$ of $\frac{1}{6}$ of 14800 feet, or 1644,44 $a \times \frac{c}{2} = 5154$ feet.

And if the chains merely sustain themselves at their utmost tenacity, 5154×9 will give 46385 feet, equal to 8,785 miles, or somewhat more than 8 miles and three-quarters.

But this case is purely hypothetical, for the purpose of ascertaining a limit, since ζ, the mass or weight of the chain must be infinite, and consequently its length: the figure approaching indefinitely near to that of a chain sustaining itself from an infinite height, which figure is identical with that of a building, capable so far as pressure and the strength of materials are alone concerned, of being carried to any elevation whatever. This figure is readily determined:

Let $a =$ the section of such a building at its base,
$y =$ the section at any height,
$x =$ that height;

Then, since the section and the superincumbent pressure must always be in the same proportion to each other, $\dot{x}$ and $\frac{\dot{y}}{y}$ are in a constant ratio. Let then $\frac{\dot{x}}{m} = -\frac{\dot{y}}{y}$ where m is the modulus of pressure in the given material; but when $x = o, y = a$, therefore $\frac{x}{m}$ = the nat. log. $\frac{a}{y}$; or $\frac{x}{\text{A} \cdot m}$ = the tab. log. $\frac{a}{y}$. A = 2,3025851; but if ε and γ the homologous sides or diameters of these sections; then, $\frac{x}{2 \cdot \text{A} \cdot m}$ = tab. log. $\frac{\varepsilon}{\gamma}$.

Finally, I would notice a correction of frequent use in practical surveying, to be deduced from the properties of the catenary curve.

When the measuring chain is extended over ground uneven, intersected by ditches, or made soft by water, it cannot be laid flat, but must be elevated at both its extremities, while the middle just touches the surface: thus giving the measurement too great by the difference between the whole perifery and the double ordinate.

Let z = the half length of the chain.

x = the elevation at each end equal to the depths of curvature.

Then Equ. B. No. 2. $y = a \times$ nat. log. $\frac{z + x}{z - x}$,

And Equ. A. No. 3. $a = \frac{z^2 - x^2}{2x}$; therefore

$$y = \frac{z^2 - x^2}{2x} \times \text{nat. log.} \frac{z + x}{z - x}.$$

But when x is very small in comparison of z, the nat. log. of $\frac{z + x}{z - x}$ becomes $\frac{2x}{z}$, and

$$y = \frac{z^2 - x^2}{2x} \times \frac{2x}{z} = z - \frac{x^2}{z};$$

$\frac{x^2}{z}$ is therefore the difference between half the chain and the

ordinate. If x be expressed in parts of the whole chain, $4\,x^2$ will be the correction for the difference between the perifery and double ordinate.

If x (the elevation at each end) be one link of the common measuring chain, $4\,x^2 = \frac{1}{25}$ of a link, $\frac{1}{25}$ of $\frac{66}{100}$ of a foot $= 0.3168$ of an inch, varying as the squares of x.

If half the chain were considered as a straight line, and the hypothenuse of a right angled triangle, the horizontal distance would be $z - \frac{x^2}{2z}$, giving but one half of the true difference, 0,1584 parts of an inch.

And if the chain were supposed to be in the arc of a circle, $z = y + \frac{y^3}{6a^2}$, &c. And $y = \sqrt{2ax - x^2}$ (when x is very small in comparison with a) $= \sqrt{2ax}$. Therefore $a = \frac{y^2}{2x}$.

And since y is also small in comparison of a, the second term of the series $\left(\frac{y^3}{6a^2}\right)$ will be the difference between the ordinate and the arc. Then substituting $\frac{y^4}{4x^2}$ for a^2, $\frac{y^3}{6a^2} = \frac{2x^2}{3y}$; or if x be expressed in parts of the whole chain, $= \frac{8}{3}\,x^2$ will be the whole correction, $= 0.2112$ parts of an inch, or two-thirds of the true difference.

Formulæ might readily be constructed for different elevations of the extremities of the chain, but they would prove much too complicated for practical use.

One further observation may be applicable to suspension bridges, wholly unconnected with the preceding investigations.

In the event of their wanting stability to counteract and restrain undulatory motion, the ballustrades may be carried

to any required height, and rendered inflexible by diagonal braces; and if further means were required for imparting stability, such braces might be adjusted with screws to the suspension rods themselves, after these rods had acquired their exact positions, on the completion of the work.

Table I.— Ordinary Catenary.

$y = 100$.

a.	N.	x.	z.	T.	Angle.
					° ′ ″
2000	1.051271	2.500511	100.041474	2002.500511	87 8 11
1950	1.052619	2.564593	100.042440	1952.564593	87 3 46
1900	1.054041	2.632163	100.045727	1902.632163	86 59 8
1850	1.055541	2.703298	100.047540	1852.703298	86 54 15
1800	1.057127	2.778421	100.050163	1802.778421	86 49 6
1750	1.058807	2.857914	100.054318	1752.857914	86 43 40
1700	1.060588	2.942018	100.057566	1702.942018	86 37 53
1650	1.062480	3.031204	100.060788	1653.031204	86 31 46
1600	1.064494	3.125974	100.064421	1603.125974	86 25 16
1550	1.066642	3.226852	100.068245	1553.226852	86 18 21
1500	1.068939	3.334558	100.073939	1503.334558	86 10 59
1450	1.071399	3.449618	100.078929	1453.449618	86 3 6
1400	1.074041	3.572907	100.084490	1403.572907	85 54 39
1350	1.076886	3.705344	100.090750	1353.705344	85 45 35
1300	1.079958	3.847958	100.097440	1303.847958	85 35 45
1250	1.083286	4.002035	100.105463	1254.002035	85 25 16
1200	1.086903	4.168981	100.114680	1204.168981	85 13 51
1150	1.090849	4.350543	100.125801	1154.350543	85 1 26
1100	1.095169	4.548545	100.137346	1104.548545	84 47 54
1050	1.099920	4.765440	100.150553	1054.765440	84 33 5
1000	1.105170	5.004084	100.165906	1005.004084	84 16 48

The column in Table I. marked N (where the numbers equal $e^{\frac{y}{a}}$) is given as the medium conducting to all the subsequent calculations.

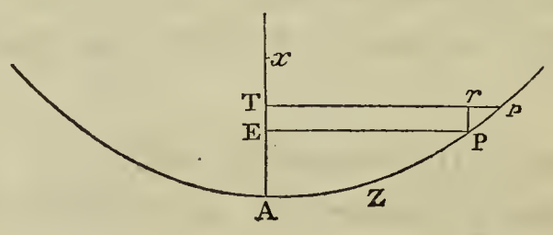


Table I. *continued.*—The Ordinary Catenary.

$y = 100$.

a.	N.	*x.*	*z.*	T.	Angle.
					° ′ ″
1000	1.105170	5.004084	100.165906	1005.004084	84 16 48
980	1.107428	5.106408	100.173025	985.106408	84 9 49
960	1.109785	5.213007	100.180582	965.213007	84 2 13
940	1.112247	5.324098	100.188974	945.324098	83 54 58
920	1.114822	5.440045	100.196191	925.440045	83 47 4
900	1.117519	5.561266	100.205825	905.561266	83 38 48
880	1.120344	5.687876	100.214837	885.687876	83 30 11
860	1.123309	5.820479	100.225255	865.820479	83 21 9
840	1.126423	5.959364	100.235949	845.959364	83 11 42
820	1.129698	6.105033	100.247321	826.105033	83 1 47
800	1.133148	6.258102	100.260296	806.258102	82 51 23
780	1.136785	6.418938	100.273356	786.418938	82 40 28
760	1.140627	6.588360	100.288153	766.588360	82 28 57
740	1.144691	6.767004	100.304328	746.767004	82 16 50
720	1.148996	6.955577	100.321527	726.955577	82 4 3
700	1.153564	7.154926	100.339869	707.154926	81 50 33
680	1.158422	7.366193	100.360765	687.366193	81 36 15
660	1.163595	7.590181	100.382517	667.590181	81 21 6
640	1.169118	7.828368	100.407143	647.828368	81 5 1
620	1.175025	8.081923	100.433570	628.081923	80 47 54
600	1.181360	8 352608	100 463404	608.352608	80 29 40
580	1.188169	8.642033	100.495985	588.642033	80 10 11
560	1.195508	8.952299	100.532176	568.952299	79 49 27
540	1.203419	9.283888	100.562366	549.283888	79 27 2
520	1.212043	9.645021	100.617335	529.645021	79 2 56
500	1.221402	10.033315	100.667683	510.033315	78 36 59
480	1.231625	10.454508	100.725490	490.454508	78 8 55
460	1.242830	10.912412	100.789382	470.912412	77 38 28
440	1.255172	11.412622	100.863052	451.412622	77 5 23
420	1.268829	11.961025	100.947150	431.961025	76 29 6
400	1.284025	12.565207	101.044792	412.565207	75 49 22
380	1.301032	13.233994	101.158163	393.233994	75 5 35
360	1.320192	13.978365	101.290757	373.978365	74 17 7
340	1.341941	14.812141	101.447796	354.812141	73 32 10
320	1.366837	15.752501	101.635337	335.752501	72 22 46
300	1.395612	16.821529	101.862069	316.821529	71 14 44
280	1.429239	18.047685	102.139232	298.047685	69 57 31
260	1.469049	19.468993	102.483745	279.468993	68 29 13
240	1.516896	21.126437	102.893226	261.126437	66 47 38
220	1.575420	23.118850	103.473548	243.118850	64 48 38
200	1.648721	25.525175	104.219022	225.525175	62 28 34
180	1.743908	28.559946	105.343499	208.559946	59 39 43
160	1.868245	32.280531	106.638654	192.280531	56 19 0
140	2.042722	37.258541	108.722538	177.258541	52 10 2
120	2.300975	44.134402	111.982596	164.134402	46 58 48
100	2.718281	54.308027	117.520071	154.308027	40 23 42
95	2.865180	57.674415	119.517684	152.674415	38 28 45
90	3.037731	61.511583	121.884206	151.511583	36 26 34
85	3.240907	65.852160	124.624934	150.852160	34 17 44
80	3.490342	71.073875	128.153485	151.073875	31 58 28
75	3.793667	77.147407	132.377616	152.147407	29 32 4
70	4.172733	84.433443	137.657866	154.433443	26 57 10

Table II.—The Ordinary Catenary.

$a = 100$.

N.	*y*.	*x*.	*z*.	T.	Angle.
					° ′ ″
1.010050	1	.004999	1.000000	100.004999	89 25 39
1.020201	2	.020000	2.000100	100.020000	88 51 15
1.030454	3	.045001	3.000398	100.045001	88 16 53
1.040810	4	.080007	4.000992	100.080007	87 42 31
1.051271	5	.125025	5.002074	100.125025	87 8 11
1.061836	6	.180050	6.003540	100.180050	86 33 51
1.072508	7	.245098	7.005701	100.245098	85 59 33
1.083287	8	.320170	8.008520	100.320170	85 25 16
1.094174	9	.405271	9.012128	100.405271	84 51 1
1.105170	10	.500408	10.016591	100.500408	84 16 48
1.116278	11	.605609	11.022190	100.605609	83 42 36
1.127496	12	.720855	12.028744	100.720855	83 8 37
1.138828	13	.846186	13.036613	100.846186	82 34 20
1.150273	14	.981591	14.045708	100.981591	82 0 14
1.161834	15	1.127107	15.056292	101.127107	81 26 15
1.173510	16	1.282710	16.068289	101.282710	80 52 17
1.185304	17	1.448471	17.081928	101.448471	80 18 22
1.197217	18	1.624373	18.097326	101.624373	79 44 31
1.209249	19	1.810427	19.114472	101.810427	79 10 43
1.221402	20	2.006663	20.133536	102.006663	78 36 59
1.233678	21	2.213114	21.154685	102.213114	78 3 19
1.246076	22	2.429763	22.177836	102.429763	77 29 43
1.258600	23	2.656680	23.203319	102.656680	76 56 11
1.271249	24	2.893847	24.231042	102.893847	76 22 45
1.284025	25	3.141302	25.261197	103.141302	75 49 22
1.296929	26	3.399061	26.293838	103.399061	75 16 5
1.309964	27	3.667187	27.329212	103.667187	74 42 53
1.323129	28	3.945662	28.367237	103.945662	74 9 46
1.336427	29	4.234542	29.408157	104.234542	73 36 44
1.349858	30	4.533833	30.451966	104.533833	73 3 48
1.363424	31	4.843577	31.498822	104.843577	72 30 58
1.377127	32	5.163822	32.548877	105.163822	71 58 13
1.390968	33	5.494589	33.602210	105.494589	71 25 35
1.404947	34	5.835881	34.658818	105.835881	70 53 3
1.419067	35	6.187768	35.718931	106.187768	70 20 36
1.433329	36	6.550276	36.782623	106.550276	69 48 18
1.447734	37	6.923431	37.849968	106.923431	69 16 6
1.462284	38	7.307284	38.921115	107.307284	68 44 0
1.476980	39	7.701863	39.996336	107.701863	68 12 1
1.491824	40	8.107217	41.075182	108.107217	67 40 10
1.506817	41	8.523379	42.158320	108.523379	67 8 25
1.521961	42	8.950402	43.245697	108.950402	66 36 48
1.537257	43	9.388315	44.337384	109.388315	66 5 19
1.552706	44	9.837146	45.433453	109.837146	65 33 57
1.568312	45	10.297011	46.534188	110.297011	65 2 43
1.584073	46	10.767851	47.639448	110.767851	64 31 46
1.599994	47	11.249817	48.749582	111.249817	64 0 39
1.616074	48	11.742877	49.864522	111.742877	63 29 49
1.632315	49	12.247092	50.984407	112.247092	63 59 7
1.648721	50	12.762587	52.109512	112.762587	62 28 34

Table II. *continued.*—The Ordinary Catenary.

$a = 100$.

N.	*y*.	*x*.	*z*.	T.	Angle.
					° ′ ″
1.665290	51	13.289300	53.239600	113.289300	61 58 9
1.682027	52	13.827388	54.375311	113.827388	61 27 53
1.698932	53	14.376853	55.516346	114.376853	60 57 45
1.716006	54	14.937727	56.662872	114.937727	60 27 46
1.733252	55	15.510107	57.815092	115.510107	59 57 56
1.750672	56	16.094061	58.973138	116.094061	59 28 14
1.768266	57	16.689588	60.137011	116.689588	58 58 42
1.786037	58	17.296790	61.306900	117.296790	58 29 19
1.803988	59	17.915770	62.483020	117.915770	58 0 5
1.822118	60	18.546493	63.665306	118.546493	57 31 1
1.840431	61	19.189099	64.854000	119.189099	57 2 5
1.858927	62	19.843586	66.049113	119.843586	56 33 20
1.877610	63	20.510098	67.250901	120.510098	56 4 43
1.896480	64	21.188633	68.459366	121.188633	55 36 16
1.915540	65	21.879300	69.674600	121.879300	55 7 59
1.934792	66	22.582171	70.897028	122.582171	54 39 52
1.954237	67	23.297283	72.126416	123.297283	54 11 54
1.973877	68	24.024709	73.362990	124.024709	53 44 6
1.993715	69	24.764560	74.606930	124.764560	53 16 28
2.013752	70	25.516873	75.858326	125.516873	52 48 59
2.033990	71	26.281725	77.117274	126.281725	52 21 41
2.054433	72	27.059265	78.384034	127.059265	51 54 33
2.075080	73	27.849426	79.658573	127.849426	51 27 34
2.095935	74	28.652451	80.941048	128.652451	51 0 46
2.117000	75	29.468327	82.231672	129.468327	50 34 8
2.138276	76	30.297123	83.530476	130.297123	50 7 40
2.159766	77	31.138956	84.837643	131.138956	49 41 22
2.181472	78	31.993903	86.153296	131.993903	49 15 14
2.203396	79	32.862044	87.477555	132.862044	48 49 16
2.225540	80	33.743457	88.810542	133.743457	48 23 29
2.247907	81	34.638263	90.152436	134.638263	47 57 52
2.270500	82	35.546581	91.503418	135.546581	47 32 25
2.293318	83	36.468371	92.863428	136.468371	47 7 8
2.316366	84	37.403837	94.232762	137.403837	46 42 2
2.339646	85	38.353056	95.611543	138.353056	46 17 6
2.363160	86	39.316110	96.999880	139.316110	45 52 20
2.386910	87	40.293084	98.397915	140.293084	45 27 45
2.410900	88	41.284143	99.805856	141.284143	45 3 20
2.435129	89	42.289243	101.223656	142.289243	44 39 5
2.459602	90	43.308592	102.651607	143.308592	44 15 1
2.484322	91	44.342313	104.089886	144.342313	43 51 7
2.509290	92	45.390455	105.538544	145.390455	43 27 23
2.533983	93	46.430931	106.967368	146.430931	43 4 18
2.559981	94	47.530444	108.467655	147.530444	42 40 26
2.585709	95	48.622506	109.948393	148.622506	42 17 13
2.611696	96	49.729447	111.440152	149.729447	41 54 10
2.637944	97	50.851184	112.943315	150.851184	41 31 18
2.664455	98	51.988313	114.457186	151.988313	41 8 36
2.691234	99	53.140537	115.982862	153.140537	40 46 4
2.718281	100	54.308027	117.520072	154.308027	40 23 42

Table III. The Catenary of equal strength.

$y = 100$.

a.	x.	z.	ζ.	T.	Angle.
					° ′ ″
1000	5.008288	100.166600	100.334300	1005.020800	84 16 13
980	5.110881	100.173640	100.348276	985.124220	84 9 12
960	5.217781	100.181250	100.363200	965.232000	84 1 54
940	5.329126	100.188850	100.378652	945.344276	83 54 16
920	5.445471	100.197071	100.395276	925.461672	83 46 19
900	5.566977	100.202654	100.413000	905.584230	83 38 1
880	5.694003	100.215533	100.432288	885.712432	83 29 20
860	5.827073	100.225792	100.452730	865.846882	83 20 15
840	5.966506	100.237329	100.475340	845.987772	83 10 44
820	6.112609	100.247806	100.497724	826.135404	83 0 45
800	6.266274	100.261054	100.523680	806.290880	82 50 16
780	6.427811	100.274596	100.551048	786.454344	82 39 15
760	6.598152	100.289657	100.580680	766.626896	82 27 40
740	6.777369	100.305695	100.613064	746.808518	82 15 25
720	6.966790	100.322732	100.647648	727.000675	82 2 32
700	7.167238	100.342923	100.685480	707.204050	81 48 53
680	7.379542	100.362168	100.726972	687.419752	81 34 26
660	7.604848	100.384645	100.772166	667.647826	81 19 7
640	7.844443	100.409125	100.821568	647.892736	81 2 51
620	8.099715	100.436355	100.876232	628.152876	80 45 31
600	8.370382	100.465969	100.936080	608.430840	80 27 2
580	8.663690	100.498855	101.002534	588.728710	80 7 17
560	8.976381	100.535447	101.076360	569.048704	79 46 7
540	9.312582	100.576282	101.158740	549.393354	79 23 23
520	9.675126	100.621836	101.250968	529.765704	78 58 53
500	10.067350	100.679481	101.362400	510.169400	78 32 27
480	10.552010	100.780247	101.472192	490.668864	78 3 48
460	10.956213	100.796941	101.605490	471.087748	77 32 39
440	11.462781	100.872044	101.757920	451.613404	76 58 41
420	12.018908	100.958305	101.933328	432.192558	76 21 29
400	12.630692	101.056700	102.136560	412.832200	75 40 33
380	13.312576	101.174410	102.373976	393.548520	74 55 19
360	14.071210	101.311236	102.653784	374.349852	74 5 4
340	14.922900	101.473699	102.986884	355.255222	73 8 53
320	15.886128	101.668413	103.387488	336.287040	72 5 42
300	16.984763	101.904940	103.875990	317.474760	70 54 5
280	18.250135	102.196102	104.480264	298.858028	69 32 14
260	19.729226	102.564124	105.241136	280.497074	67 57 47
240	21.465587	103.025715	106.219200	262.454784	66 7 36
220	23.555838	103.632647	107.507994	244.863168	63 57 23
200	26.116574	104.447443	109.260480	227.898480	61 21 7
180	29.336487	105.580330	111.739482	211.862484	58 10 8
160	33.525185	107.228464	115.437376	197.296208	54 11 24
140	39.241137	109.779803	121.380952	185.292618	49 4 28
120	47.626016	114.104417	132.093348	178.461912	42 15 12
100	61.562643	122.619114	155.740770	185.081570	32 42 15
95	66.748734	126.148321	166.629316	191.808059	29 41 19
90	73.141390	130.727676	181.797084	202.855068	26 20 16
85	81.313401	136.905055	204.267512	221.246959	22 35 35
80	92.332784	145.717467	240.765568	253.708616	18 22 48
75	108.536763	159.466590	309.878850	318.825817	13 36 20
70	136.763450	184.926359	488.855143	493.841432	8 8 56

Table IV.—The Catenary of equal strength.

$a = 100$.

y.	x.	z.	ζ.	T.	Angle.
					° ′ ″
1	.004999	.999990	1.00001	100.00500	89 25 37
2	.020003	2.000088	2.00022	100.020006	88 51 14
3	.045005	3.000431	3.00088	100.045016	88 16 52
4	.080021	4.001021	4.00208	100.080054	87 42 29
5	.125046	5.002067	5.00415	100.125125	87 8 6
6	.180107	6.003541	6.00714	100.180270	86 33 44
7	.245198	7.005697	7.01143	100.245499	85 59 21
8	.323389	8.008498	8.01706	100.320852	85 24 58
9	.405548	9.012161	9.02436	100.406373	84 50 46
10	.500828	10.016660	10.03343	100.502080	84 16 13
11	.606218	11.022229	11.04456	100.608062	83 41 50
12	.721234	12.028425	12.05789	100.723845	83 7 28
13	.847386	13.036754	13.07372	100.850992	82 33 5
14	.983205	14.045921	14.09215	100.988063	81 58 42
15	1.129248	15.056560	15.11351	101.135644	81 24 20
16	1.285490	16.068670	16.13791	101.293792	80 49 57
17	1.452011	17.082468	17.16567	101.462608	80 15 34
18	1.628815	18.097959	18.19691	101.642158	79 41 12
19	1.815961	19.115360	19.23197	101.832558	79 6 49
20	2.013470	20.134658	20.27097	102.033830	78 32 23
21	2.221395	21.156371	21.31424	102.246255	77 58 4
22	2.439770	22.179619	22.36191	102.469780	77 23 41
23	2.668651	23.205504	23.41433	102.704585	76 49 19
24	2.908061	24.233742	24.47164	102.950768	76 14 56
25	3.158106	25.264601	25.53424	103.208504	75 40 33
26	3.418774	26.297360	26.60212	103.477887	75 6 11
27	3.690164	27.334154	27.67581	103.759100	74 31 48
28	3.972311	28.373174	28.75540	104.052264	73 57 25
29	4.265294	29.415243	29.84128	104.357567	73 23 3
30	4.569158	30.460378	30.93360	104.675156	72 48 40
31	4.883983	31.508739	32.03269	105.005213	72 14 17
32	5.209839	32.560521	33.13891	105.347935	71 39 55
33	5.546782	33.615738	34.25243	105.703501	71 5 32
34	5.894915	34.674639	35.37366	106.072131	70 31 9
35	6.254281	35.737235	36.50280	106.454005	69 56 47
36	6.624997	36.803792	37.64030	106.849383	69 22 24
37	7.007106	37.874291	38.78626	107.258446	68 48 2
38	7.400749	38.948988	39.94126	107.681495	68 13 39
39	7.805967	40.027947	41.10545	108.118722	67 39 16
40	8.222888	41.111407	42.27931	108.570433	67 4 54
41	8.651589	42.199404	43.46308	109.036870	66 30 31
42	9.092196	43.292198	44.65724	109.518354	65 56 8
43	9.544771	44.389841	45.86509	110.015128	65 21 46
44	10.009478	45.492556	47.07804	110.527566	64 47 23
45	10.486371	46.600436	48.30547	111.042096	64 13 0
46	10.975622	47.713735	49.54487	111.600602	63 38 38
47	11.477312	48.832499	50.79655	112.161892	63 4 15
48	11.991595	49.957023	52.06108	112.740211	62 29 52
49	12.518572	51.088569	53.34078	113.335897	61 55 32
50	13.058418	52.223810	54.63024	113.949396	61 21 7

Table IV. *continued.*—The Catenary of equal strength.

$a = 100$.

y.	x.	z.	ζ.	T.	Angle.
					° ′ ″
51	13.611226	53.366417	55.93584	114.581052	60 46 44
52	14.177189	54.515494	57.25618	115.231377	60 12 22
53	14.756401	55.676950	58.59167	115.900748	59 37 59
54	15.349077	56.833577	59.94296	116.589191	59 3 36
55	15.955315	58.002974	61.31049	117.298661	58 29 14
56	66.575346	59.179619	62.69495	118.028208	57 54 51
57	17.209276	60.363609	64.09682	118.778802	57 20 29
58	17.857313	61.555215	65.51678	119.551032	56 46 6
59	18.519676	62.754711	66.95554	120.345521	56 11 43
60	19.196491	63.962210	68.41362	121.162801	55 37 21
61	19.888020	65.178046	69.89186	122.003580	55 2 58
62	20.594400	66.402358	71.39084	122.868440	54 28 35
63	21.315910	67.635500	72.91145	123.758155	53 54 13
64	22.052701	68.877606	74.45432	124.673361	53 19 50
65	22.805074	70.129059	76.02042	125.614906	52 45 27
66	23.573186	71.389994	77.61043	126.583487	52 11 5
67	24.357371	72.660825	79.22540	127.580036	51 36 42
68	25.157787	73.941697	80.86608	128.605306	51 2 19
69	25.974778	75.233031	82.53360	129.660301	50 27 57
70	26.808551	76.535188	84.22878	130.745895	49 53 34
71	27.659459	77.848058	85.95285	131.863168	49 19 11
72	28.527710	79.172384	87.70674	133.013056	48 44 49
73	29.413697	80.508436	89.49175	134.196771	48 10 26
74	30.317647	81.856432	91.30890	135.415343	47 36 4
75	31.239989	83.216866	93.15964	136.670112	47 1 41
76	32.180961	84.589966	95.04510	137.962209	46 27 18
77	33.140961	85.975963	96.96618	139.293095	45 52 56
78	34.120421	87.375961	98.92611	140.664048	45 18 33
79	35.119618	88.789594	100.92453	142.076604	44 44 10
80	36.139051	90.214639	102.96381	143.532386	44 9 48
81	37.179043	91.660396	105.04542	145.032900	43 35 25
82	38.240111	93.118455	107.17133	146.579992	43 1 2
83	39.322622	94.592159	109.34320	148.175357	42 26 40
84	40.427139	96.082135	111.56319	149.821051	41 52 17
85	41.554052	97.588753	113.82816	151.518952	41 17 54
86	42.703981	99.112699	116.15555	153.271369	40 43 32
87	43.877350	100.654374	118.53239	155.080397	40 9 9
88	45.074822	102.214506	120.96637	156.948608	39 34 46
89	46.296874	103.793554	123.45986	158.878369	39 0 24
90	47.544231	105.392291	126.01578	160.872559	38 26 1
91	48.817411	107.011233	128.63685	162.933851	37 51 39
92	50.117199	108.651210	131.32634	165.065469	37 17 16
93	51.444173	110.312786	134.08729	167.270444	36 42 53
94	52.799201	111.996881	136.92343	169.552431	36 8 31
95	54.182891	113.704104	139.83816	171.914846	35 34 8
96	55.596244	115.435462	142.83573	174.361831	34 59 45
97	57.039914	117.191641	145.92002	176.897299	34 25 23
98	58.514946	118.973717	149.09580	179.525931	33 51 0
99	60.032087	120.782488	152.36759	182.252247	33 16 37
100	61.562647	122.619117	155.74077	185.081573	32 42 15

XVI. *On magnetic influence in the solar rays.* *By* SAMUEL HUNTER CHRISTIE, *Esq. M. A. F. R. S. of Trinity College, Cambridge; Fellow of the Cambridge Philosophical Society: of the Royal Military Academy. Communicated November* 15, 1825.

Read January 19, 1826.

THE object of the present communication is to show, by a series of experiments, that the solar rays possess sensible magnetic properties, which are observable in the vibrations of a magnetised needle exposed to those rays, independently of the effects produced by the heat which they impart. I propose likewise to point out the changes which take place in the intensity of a magnetised needle from changes of temperature, as deducible from the times of its vibration. I have before stated in my paper *on the effects of temperature on the intensity of magnetic forces*, that, in deducing the terrestrial magnetic intensity by means of the vibrations of a needle, a correction ought to be introduced where the observations have been made at different temperatures. I had not at the time made any experiments by which I could ascertain how far changes in the temperature of a needle would be sensible in the time of its vibration; and the first observations which I made with this view being with a light needle, did not give very decided results: they however led me first to notice the very singular fact, that a magnetic needle comes to rest more quickly when vibrated exposed to the rays of the sun, than when vibrated in the shade.

In order to ascertain the effect which changes of temperature have on the times of vibration of a needle, it is necessary to know the temperature of the needle itself during the observations, and I saw no better means of ascertaining this, even approximately, than to vibrate it in the shade and then exposed to the rays of the sun, and to consider the temperature of the needle to be that indicated by a thermometer near to it. On my first doing this, I found, that although I could easily mark the 50th vibration when the needle was shaded, I could not distinguish beyond the 40th when it was exposed. I at the same time found that the time of vibration was slightly diminished at the higher temperature, instead of being increased, as I had reason to expect. As however the needle was not vibrated in the same spot in the two cases, the diminution in the time of vibration and of the arc when it was exposed, might be independent of the change of temperature and of any influence in the solar rays. To avoid any uncertainty arising from difference of disturbing causes in two situations, I placed the compass out of doors, with a screen composed intirely of wood, supported at the height of four feet above it, and by removing which the rays of the sun struck directly on the needle. A thermometer having the bulb near to the compass-box indicated nearly the temperature of the needle. When the shutter was up, so that the needle vibrated in the shade, I could very distinctly note the 100th vibration; but when it was removed and the needle vibrated exposed to the sun's rays, I could not so distinctly mark the 75th. I made use of a needle six inches long, weighing 42.75 grains, and contained in a brass compass-box with a glass cover: the needle was suspended by a fine hair, and commenced vibrating 30° from zero.

Needle exposed to the sun; or being in shade.	Thermometer.	Time of performing 50 vibrations.	Extent of arc of vibration from zero at 50th vibration.
Shade . .	60.9	118.8 seconds.	Not observed.
Sun . .	91.5	118.0	Not observed.
Shade . .	76.0	118.8	5° 00′
Sun . .	75.3	118.0	2 30
Sun . .	90.4	118.4	2 45
Sun . .	91.4	118.0	2 30
Sun . .	89.4	118.4	2 30
Shade . .	81.6	118.7	4 45

From these observations it is evident, that although the needle vibrated rather more rapidly, yet it came more quickly to a state of rest when exposed to the rays of the sun, than when in the shade. The latter effect appears to have been produced independently of the heat of the rays; since when the thermometer had risen only to 75.3, the terminal arc had decreased from 5° to 2° 30′. These observations were made between noon and 1^h 30^m on the 4th of June 1824, and I had no opportunity of repeating them during that summer.

As the apparent increase of intensity at an increased temperature, indicated by a small diminution in the time of vibration, excited my surprise as much as the more rapid decrease of the arcs of vibration when the needle was exposed to the rays of the sun, I resolved to make use of a balance of torsion, in order to deduce the changes of intensity from the deviation caused by torsion, as well as from the times of vibration; and that there might be less ambiguity in the results, I employed a much more powerful needle, its weight being 197 grains, and length 6 inches as before. This needle was suspended by a wire (No. 22) 22.9 inches long, and free from torsion when the needle pointed to zero. The observations

contained in the following table were made between 1 and 2 o'clock after noon on the 30th of May, 1825; as before, the vibrations commenced 30° from zero.

Needle exposed to the sun; or being in shade.	Thermometer.	Index on the micrometer of torsion.	Deviation of the needle.	Time of performing 50 vibrations.	Extent of arc of vibration from zero at 50th vibration.
Shade.	60	0°	- - -	158.35 seconds.	5° 45′
	60	0	- - -	158.25	5 40
	61	360	19 00		
Sun, but not strong.	73	360	19 10		
	82	360	19 16		
	80	0	- - -	158.7	3 10
	85	0	- - -	158.7	3 15
	87	0	- - -	159.3	3 05

Here, as before, the terminal arc was in all cases diminished when the needle vibrated exposed to the solar rays, but the increase of temperature caused a diminution of intensity, whether the intensity be estimated by the time of vibration or by the deviation caused by torsion. Estimating it by the latter, we shall have, since the directive force varies directly as the torsion and inversely as the sine of the deviation,

Directive force at temperature $61° = \frac{341}{\text{sin. } 19°} = 1047.186$;

Directive force at temperature $82° = \frac{340.73}{\text{sin. } 19° 16'} = 1032.624$.

So that with an increase of temperature of 21° there appears to have been a decrease of intensity of 14.552. This would give the decrement of intensity .00067 for an increment of 1° in temperature between the temperatures 61° and 82°, the intensity at 61° being considered 1. From the experiments with powerful magnets, detailed in my former paper (Phil. Trans. 1825. p. 1.) it appears that, considering the intensity at 62° as 1, the decrement of intensity corresponding to

an increment of temperature of 1°, between 62.05 and 77.65, would be .000586, from which the foregoing result does not differ greatly.

If we estimate the change of intensity by the difference in the times of vibration, calling the intensity at the temperature 60°, 1; we shall have,

$$\text{Intensity at temperature } 84^\circ = \frac{(158.3)^2}{(158.9)^2} = .992462.$$

We have therefore here a decrease of intensity .007538, in consequence of an increase of 24° in temperature; or a decrement .000314 corresponding to an increment 1° in temperature, between the temperatures 60° and 84°. This is considerably less than was deduced from the deviation due to torsion, which arises in some measure from the acceleration from torsion being very nearly constant at different temperatures, and therefore tending to diminish the difference in the times of vibration.

The following observations were made between 11^h 30^m and 12^h 40^m of the 10th of June, 1825, under very favourable circumstances, the sun shining clear and strong the whole time. The heavy needle employed in the last observations was again made use of; it now rested on the pivot. The point where the vibrations commenced for each 40 vibrations was 90° from zero.

Needle exposed to the sun; or being in shade.	Thermometer.	Time of performing 40 vibrations.	Extent of arc of vibration from zero at 40th vibration.	Times of commencing and of concluding the observations.
Shade.	72.5	135.0 seconds.	15° 30′	11h 30m
	75.0	135.0	14 30	
	75.0	135.0	13 30	
	76.0	134.8	12 00	11 52
Mean .	74.6	134.95	13 52	
Sun.	90.0	135.3	8 00	11 55
	105.0	135.7	9 00	
	109.0	136.2	8 30	
	112.0	136.2	8 20	12 12
Mean .	104.0	135.85	8 27	
Shade.	87.0	135.4	12 30	12 20
	84.0	135.5	14 00	
	82.0	135.3	13 00	
	81.0	135.1	12 00	12 40
Mean .	83.5	135.32	12 57	

Deducing the changes of intensity from the times of vibration, the observations at 74°.6 and 104° give .00045, and those at 83°.5 and 104° give .00038 as the decrement in intensity corresponding to an increment in temperature of 1°, one of the observations being in the shade, and the other in the sun in each case; but from the observations at 74°.6 and 83°.5, where both were made in the shade, we have .00061: and again, from the observations at 90° and 110°.5 (the mean of 109° and 112°, the times of vibration at these temperatures being the same,) where both were made in the sun, we obtain .00064 as the decrement, the intensity at the lower temperature being in each case considered as 1. The small disagreement in the first two results may arise from errors in determining the temperature of the needle at the time of vibration, which, from the rapid changes that took

place, could not be ascertained with precision; and the much greater difference between either of these and the other two may possibly be attributable to the same source, though I shall have occasion at the conclusion of this paper to point out another, and, I conceive, the true cause of this difference. Had my object been to give a correction for difference of temperature, to be applied generally to the intensities deduced from the times of vibration, a closer agreement in the results would have been desirable; but although such is not my object, I wish, from these experiments, to point out the necessity of such correction, when we would deduce the magnetic intensity from the times of vibration of a needle in different parts of the earth, where the temperatures during the observations are necessarily different.

The observations which I have detailed are, I think, quite conclusive as establishing the fact, that the rays of the sun had a tendency to check the vibrations of the needle, particularly those in the last table; since here, on the needle being exposed to the sun, the terminal arc was reduced from nearly 14° to 8½°, and again on excluding its rays that arc was increased to nearly 13°: the only question is whether this would take place under all circumstances; that is, whether the influence be exerted in all cases directly on a magnetised needle and independently of changes in its temperature and intensity, or whether it was an effect produced on the metal of the box by a change in its temperature. That the effect is independent of changes in the temperature and intensity of the needle will appear from comparing the first observation in the sun with the first of the second set in the shade; the temperatures and times of vibration are very

nearly the same in the two cases, and yet in the sun the terminal arc is only 8°, whereas it is 12° 30′ in the shade. That the diminution of the arc does not arise from an increase of temperature in the box appears from this, that although the thermometer indicated 90° at the first observation in the sun, and 87° at the first in the shade, it is probable that the temperature of the brass compass-box was higher in the latter case than in the former, since in both this would change its temperature more slowly than the mercury in the bulb of the thermometer.

To ascertain beyond doubt whether these conclusions were correct, I placed the compass in a room where it was not exposed to the rays of the sun, and when the needle had acquired the temperature of the room, I vibrated it, and noted the time of 40 vibrations and the arc at the 40th; I then heated the compass-box over a fire until its heat was barely supportable to the hand, replaced and vibrated the needle. Instead of finding that the increased temperature of the box had diminished the terminal arc, I found that, at the end of the first 40 vibrations, it was considerably greater than when the box had been at a lower temperature, and that, as the box had cooled, the terminal arcs in the successive 40 vibrations decreased, the vibrations always commencing from 90°; and this effect was invariably produced in repeated trials. A thermometer was placed at a small distance from the compass, that any changes in the temperature of the air might be indicated: this remained nearly at the same point throughout the observations.

		Thermometer.	Time of performing 40 vibrations.	Extent of arc of vibration from zero at 40th vibration.
Observations previous to heating the compass-box.		63.0	139.65 seconds.	15° 00′
			139.2	13 00
			139.25	13 00
		64.0	139.4	13 00
Observations after the compass-box had been heated.	1st time	64.5	141.3	21 00
			139.6	12 45
			139.3	12 30
		64.7	139.5	12 30
	2d time	64.0	141.6	20 00
			140.0	15 00
			140.2	15 00
		63.5	140.0	15 30
	3d time	63.4	141.4	20 00
			140.2	14 30
			139.6	12 45
		63.0	139.7	12 00

These observations show clearly that an increased temperature on the compass-box tended to increase considerably the terminal arc, and that if the increased temperature, and consequent diminished intensity of the needle, had any tendency to diminish that arc, it was much more than counterbalanced by the effect produced on the compass-box. That such an effect should be produced on the brass is singular, and can, I think, only be accounted for on the supposition, that the capacity in brass for the developement of magnetism by induction is diminished by an increase of temperature, the vibrations of the needle being in all cases checked by the magnetism developed in the brass by the needle itself.*

* Since making the foregoing observations I have found that a similar effect, arising, I conceive, from the same cause, is produced on a copper disc vibrating under the influence of a magnet: the number of vibrations required to reduce the

I now proposed observing the effect on the terminal arc of a change of temperature, and consequently a change of intensity in the needle, other circumstances remaining precisely the same. For this purpose, I plunged the ends of the needle nearly to its centre into boiling water, and vibrated it as soon as possible afterwards. On my first doing this the pivot on which the needle vibrated was slightly injured, so that being obliged to re-magnetise the needle, in order to obtain results previous to a diminution of intensity to be compared with those after the needle had been immersed, these results could not be compared with those which I had before obtained. I mention this, to guard against any conclusions being drawn from a comparison of the times of vibration or of the terminal arcs in the following observations with those of the preceding. In consequence of the increased friction on the pivot, the arc of vibration was reduced to $5\frac{1}{2}^{\circ}$ on each side of zero at the 30th vibration, I therefore only observed that number: the vibrations commenced, as before, 90° from zero.

arc of vibration to a certain extent was, by heating the disc, increased from being less than 23 to $26\frac{1}{2}$, taking a mean of several observations. The method of vibrating metallic discs between the poles of a magnet, which I here made use of, was, I believe, first employed by Mr. WILLIAM STURGEON, of Woolwich, for the purpose of exhibiting the magnetic properties of different metals, which it does in a very striking manner.

	Thermometer.	Time of performing 30 vibrations.	Extent of arc of vibration from zero at 30th vibration.
The needle having been re-magnetised previous to immersion in boiling water.	63°	99.9 seconds. 99.8 99.7 99.7	5° 15′ 5 30 5 30 5 30
	Mean	99.775	5 26
The needle having been immersed in boiling water.	63	104.2 104.15 104.25 104.4	6 00 6 15 6 15 6 15
	Mean	104.25	6 11
The needle having been re-magnetised after immersion in boiling water.	63	100.2 100.4 100.3 100.4	6 15 6 30 6 30 6 45
	Mean	100.325	6 30

The increase here in the terminal arcs being gradual, and taking place under opposite circumstances, appears to have arisen from the friction on the pivot being gradually diminished. Taking a mean of the arcs before immersion and after it, when the needle had been re-magnetised, it is rather less than the mean arc when the intensity of the needle was reduced by an increased temperature arising from the immersion; so that an increase of temperature which diminished the intensity of the needle from 1 to 0.92, produced no sensible effect on the terminal arc. The decrease of intensity is here much greater than any that could arise from an increase of temperature derived from the direct rays of the sun; it is therefore manifest from these last experim ents, independent of any thing which I have before stated, that the heat of the sun, by diminishing the intensity, could not be the cause of

the diminution of the terminal arc. That this diminution could not arise from the increased temperature of the compass-box, the previous experiments have, I trust, satisfactorily proved: I think I may therefore safely conclude, that during the vibration of a magnetised needle exposed to the solar rays, these rays have an influence on the needle independent of the effect produced by heat, which tends to bring the needle to a state of rest.

In the first observations which I have described it appears that, although we might expect that, when the needle vibrated in the sun, the increased temperature would diminish the intensity, yet a slight acceleration took place in the time of vibration. Whether this is to be attributed to the same cause or not, it is perfectly analogous to what I have observed on vibrating a metallic disc under the influence of a magnet: the arc of vibration was much more rapidly diminished than when the disc vibrated uninfluenced by the magnet, and the times of vibration were also diminished. A copper disc 7 inches in diameter having its axis of suspension perpendicular to its plane, and at a small distance from its centre, made 286 vibrations before the arc of vibration was reduced to a certain extent; but on vibrating it between the poles of a horse-shoe magnet it made only 23 vibrations before the arc was reduced to the same extent. The times in which the disc performed 24 vibrations at different trials were:

	Freely.	Between the poles of the magnet.
24 vibrations in	35.15 seconds	34.6 seconds.
24	35.15	34.7
24	35.1	34.6
24	35.18	34.6
Time of 1 vibration	1.4635	1.4427

so that another effect of the magnet was to diminish the time of vibration of the disc. If the acceleration in the time of vibration of the needle when exposed to the sun's rays arise from a similar cause, we ought also to find that the decrement of intensity in the needle corresponding to an increase of temperature, as deduced from the times of vibration in the sun and in the shade, is less than the decrement deduced from the times of vibration at different temperatures when both observations were made in the shade, or both in the sun, and likewise less than that deduced from the deviation due to torsion; and this, from the observations, appears to have been decidedly the case. Probably, however, the accelerations in the times of vibration are only consequences of the diminution of the arcs, both in the case of the copper disc and of the needle vibrating in the sun; still this acceleration will account for these differences in the decrements of intensity.

Although we should not at present be able to point out the manner in which the rays of the sun tend to bring the needle to rest, the discovery of a fact proving magnetic influence in the solar rays must, I think, ultimately lead to important conclusions respecting the phænomena of terrestrial magnetism. On this account it is desirable that the mode of observing should be varied, and that observations should be made in climates more favourable for the purpose than our own. I regret that, in consequence of my absence from home, I could not repeat the experiments during the extremely hot and clear weather of the past summer, as it is probable that the effects might have been even more decided than those which I have detailed. Possibly the effect might

be greatly increased by placing the needle so nearly in the focus of a large lens or reflector, that the rays should be concentrated on the space in which the needle vibrated. In this case, however, the intensity of the needle might be so much diminished by the high temperature, as to render doubtful the cause of the effect observed.

The repeated failures of MORICHINI's experiment of magnetising a needle by the violet ray, even under the most favourable circumstances, and in the ablest hands, have led many to doubt whether the effects, which were in some cases observed, were to be attributed to the influence of the ray; but as the experiments which I have detailed indicate magnetic influence in the compound solar rays, and are besides easily repeated, they will, I think, tend considerably to remove these doubts.

Royal Military Academy,
November 15, 1825.

Additional observations.

Since the foregoing paper was read, having made some further observations which show more decidedly than the preceding that the effect which I have described is due to magnetic influence in the solar rays, I beg here to add them. I was satisfied that the decrease in the terminal arc, when the needle vibrated in the sun, could not be due to the increased temperature of the metallic compass-box in which the needle vibrated, since in the experiment which I have described, and which I have carefully repeated, the effect

produced by heating the box was to increase considerably that arc; yet I considered that it must remove all doubt on the subject, if the box in which the needle vibrated were of wood, or other non-metallic substance. I resolved therefore at the earliest opportunity to repeat my experiments, and to make additional ones with an apparatus, in the construction of which I had scrupulously excluded metal, the suspension of the needle alone excepted. The compass-box is of mahogany, the sides being of thick pasteboard: the graduations are on paper. Through a perforation in the middle of the glass cover a glass tube is fixed, and down this the suspending wire, which is fixed above, passes into the compass-box. The needle can be released 90° from zero by means of a wooden or glass pin, turning in the side of the box. It would have been very desirable to have repeated the experiments in a vacuum, as the effect which I had observed to be produced by vibrating the needle exposed to the sun, might possibly be attributed to changes taking place in the medium in which the needle moved; but as there would be extreme difficulty in doing this without having metal in the vicinity of the needle, I proposed to vibrate needles of copper and of glass, by the force of torsion, both in the shade and exposed to the sun, to observe the terminal arcs under those circumstances, and to compare the effects with those obtained with a magnetised needle. The needles employed are all of the same form; their length 6 inches, breadth in the middle 1.5 inches, their sides being nearly circular arcs. The magnetised needle was suspended by a very fine hard brass wire, No. 35, between $\frac{1}{300}$ and $\frac{1}{400}$ inch in diameter, and 10 inches in length; the glass needle was suspended by the same

more than counterbalanced by the time during which the glass and copper needles vibrated being greater than that for the magnetised needle. If the effects be reduced proportionally to the times, the terminal excess in the same time would be for the magnetised needle 13°.75, for the copper needle 5°.24, and for the glass needle 4°.71.

The diminution in the time of vibration of the magnetised needle when exposed to the sun, may at first sight appear singular, since there can be no doubt that, the temperature being higher, the intensity of the needle was less than when it was screened. This diminution in the time of vibration I have no doubt arose principally from the more rapid diminution of the arcs of vibration in the former case than in the latter, and likewise in some measure from the needle not recovering the same intensity of magnetism after being exposed to the high temperature of the sun's rays which it previously possessed. That these causes operated to a great extent is clearly shown by the following observations which I afterwards made. The same needle, but having its weight increased to 252 grains, was first vibrated in the shade from 90° as before, and three different observations gave me $5^m\ 58^s.8$, $5^m\ 58^s.6$, $5^m\ 58^s.6$, as the time of performing 100 vibrations, or $3^s.587$ as the mean time of 1 vibration, the terminal arc being 33 and thermometer 64.5. I then vibrated it, still in the shade, from 20°, and found that 50 vibrations were performed in $2^m\ 48^s.8$, giving $3^s.376$ as the mean time of vibration, the terminal arc being 13° and thermometer 65°. Similar observations being immediately afterwards made with the needle exposed to the sun, gave $5^m\ 59^s.4$, $5^m\ 59^s.4$, and $6^m\ 00^s$, as the time of performing 100 vibrations, or

3ˢ.596 as the mean time of one vibration, when the needle vibrated from 90°, the terminal arc being $19\frac{1}{3}°$ and thermometer 102.3; and vibrated from 20°, the time of performing 50 vibrations was 2 52.2, or the mean time of one vibration 3.445, the terminal arc being 9° and thermometer 110. The intensities in the shade and in the sun, estimated by the times of vibration in the large arcs would be 1 and .995; but estimated by the times of vibration in the small arcs 1 and .960. It appears from these observations, that in deducing the magnetic intensity in different parts of the earth from the vibrations of a needle, it is very essential to attend to the circumstance of the needle having been exposed or not to the rays of the sun during its vibration, as well as to the temperature in which the vibrations have been made.

The very small increase in the times of vibration of the glass and copper needles, when exposed to the sun above those when screened, is to be attributed to the slight expansion of the needles themselves, and perhaps of the suspending wires; but this is too small at all to account for the terminal excess with these needles. I am aware that, had the copper needle been of the same weight as the magnetised needle, and the times of vibration of all the needles more nearly the same, in the series of experiments which I have given, the results would have been more strictly comparative; but on the only day during which to the present time the sun has continued unclouded long enough for making a complete series with different needles, I was unprovided with any lighter copper; and since I have formed needles of magnetised and unmagnetised sheets of copper and of glass, all of the same form and weight, and adjusted the suspending

wire so that they shall vibrate in the same time, I have in vain made almost daily attempts to obtain a complete set of observations. The observations however which I have given are, I think, quite conclusive as to the fact of the compound solar rays being possessed of magnetic properties.

As we can scarcely suppose that the terminal excess in the case of the glass needle is due to magnetism in the glass, deducting this portion from the terminal excess with the other needles, the ratio of this excess with the magnetised needle to that with the copper needle would be 17 to 1, a result not very improbable, though the small difference in this excess with the copper and glass needles may very possibly have arisen from other causes. But if the effect with the glass needle cannot be attributed to magnetic influence any how exerted, what cause are we to assign for it? It is possible that the terminal excess in this case may have arisen from currents of air excited within the box by the rays of the sun: or probably electricity is excited in the glass needle on exposure to the rays of the sun, and the box becoming electric by induction, a drag between the needle and the box causes a diminution in the arc of vibration. The latter supposition would accord with the recent highly interesting experiments of Mr. BABBAGE. I am not aware that such effects as these have ever before been observed during vibration, and there certainly appears great difficulty in assigning any cause for them: however, until further observations may have thrown greater light on the subject, we must be satisfied with having ascertained the facts.

I have not as yet made any observations to ascertain what may be the effects when a needle vibrates exposed to the

separated rays, but having an apparatus for the purpose, I propose doing so when the season becomes more favourable for such experiments than it is at present.

Royal Military Academy,
20th April, 1826.

XVII. *On the mutual action of sulphuric acid and alcohol, with observations on the composition and properties of the resulting compound. By Mr.* HENRY HENNELL, *chemical operator at Apothecaries' Hall. Communicated by* W. T. BRANDE, *Esq. Sec. R. S.*

Read March 9, 1826.

THE following experiments were originally undertaken with the view of ascertaining the nature of that singular product of the distillation of sulphuric acid and alcohol, which has long been known in the pharmaceutical laboratory under the name of oil of wine, and which has generally been regarded by chemists as a modification of sulphuric ether. The results however of my enquiries have led me to very different conclusions, and induce me to regard it as a hitherto undescribed compound of sulphuric acid and carbon and hydrogen; the latter elements existing in the same proportions as in olefiant gas, and exerting a peculiar saturating power in respect to the acid. I have also ascertained that hydrocarbon, with an additional proportion of sulphuric acid, affords a compound which is capable of uniting with salifiable bases, and of forming a distinct series of products.

Of oil of wine.

As I originally considered the elements of oil of wine to be the same as those of ether, I endeavoured to ascertain their relative proportions by passing its vapour over red hot oxide of copper in a glass tube, in the apparatus contrived

for such decompositions by Dr. PROUT and Mr. COOPER, Trans. Soc. Arts XLI. p. 56. In these experiments I always obtained, along with the other products, a considerable proportion of sulphurous acid, and afterwards upon washing the contents of the tube with water upon a filter, it was of a bluish tint, and held sulphate of copper in solution; a result which I could not readily account for, as every precaution had been taken to free the oil of wine which I used from all adhering sulphurous and sulphuric acid.

I now added a few drops of the same oil of wine to a solution of muriate of baryta and gently heated the mixture, when not the slightest cloudiness was produced, although litmus paper indicated the existence of a free acid; but upon evaporating the mixture a precipitate fell, when it became concentrated, and on boiling it to dryness, a considerable quantity of sulphate of baryta was found in the residue: it became evident therefore that the sulphuric acid was in some state of combination which prevented its usual action upon tests, or that its elements were in some peculiar state of arrangement in the oil of wine.

To determine the quantity of sulphuric acid thus elicited, I boiled 200 grains of very carefully prepared oil of wine, free from all trace of acid, with a solution of caustic potassa to dryness; the residue was heated red hot and dissolved in water, the excess of potash being slightly supersaturated with dilute nitric acid; muriate of baryta was then added as long as it formed a precipitate, and 218,3 grains of sulphate of baryta were thus obtained. A repetition of this experiment gave the same results; so that we may conclude upon the presence of 74 grains of sulphuric acid in 200 of oil of wine.

In resuming the analysis of oil of wine by ignited oxide of copper, I found it necessary to mix it perfectly with the greater part of the oxide employed, otherwise, as in the first experiment, suphurous acid was formed in consequence of the perfect reduction of a portion of oxide, and the action of the metal thus reduced upon the sulphuric acid. With this precaution several experiments were performed, the results of which were very uniform, and as follows: 2.08 grains of oil of wine carefully freed from all adhering moisture by quicklime, were properly mixed with 200 grains of oxide of copper, and subjected with due precautions to a red heat, in the apparatus formerly adverted to: the products were 8.8 cubic inches of carbonic acid gas, and 1,54 grains of water, and these are equivalent to 0,171 of a grain of hydrogen, and 1,118 grains of carbon: 100 grains therefore of oil of wine would afford

Hydrogen	8,30
Carbon -	53,70
	62.

and the deficiency of 38 grains must be referred to sulphuric acid, a conclusion which is verified by the former experiment with solution of potassa, in which the proportion of that acid is shown to be 37 per cent. We may I think therefore conclude the above estimate to be near the truth, and the results, as respects the carbon and hydrogen, approximate nearly to the proportional quantities 6 and 1.

From the above experiment however we can only infer the composition of the hydrocarbon, which is combined with and neutralises the sulphuric acid, for in all the specimens of oil

of wine which I have examined, I have found a variable quantity of hydrocarbon held in solution, part of which spontaneously separates in a crystalline form when it has been kept for some time, or when exposed to cold, but the whole of which I have not yet devised any means of separating; this dissolved hydro-carbon, however, as future experiments will show, appears to be composed of single proportionals of its elements, we must therefore have recourse to other experiments to determine the actual weight of hydrocarbon in its neutral or atomic compound with sulphuric acid.

Having thus far made out the composition of oil of wine, I examined more carefully what had taken place during its action upon heated solutions of muriate of baryta and potash; in which case, as I have already observed, an acid had been formed not capable of precipitating baryta.

200 grains of oil of wine were placed in a flask with 5 or 6 ounces of water, and the flask set in a vessel of boiling water for an hour; precipitated carbonate of baryta was then added, and immediately dissolved with effervescence; about 90 grains of carbonate were required to neutralize the acid formed: the solution filtered and set to evaporate soon became acid, and sulphate of baryta precipitated. 200 grains more of oil of wine were treated in the same way, but instead of evaporating the baryta solution, it was precipitated by carbonate of potash; the potash solution evaporated at a temperature of 150° until it crystallized, remained perfectly neutral; the crystals were thin plates, not unlike chlorate of potash, greasy to the touch, very soluble in water and alcohol, burning when heated with a flame like that of ether, and leaving an acid sulphate of potash. A few grains of these

crystals were heated in a tube, when they fused, swelled up, and gave off a dense white vapour, which condensed into an oil-like fluid, smelling strongly of sulphurous acid; the residuary salt was an acid sulphate of potash.

The following experiments were now undertaken with a view of more accurately determining the composition of this crystalline salt.

20 grains of the crystals being heated to redness, left 10,56 grains of sulphate of potassa, equal to 4,8 sulphuric acid, 5,76 potash. 20 grains were dissolved in a solution of caustic potash, boiled to dryness, heated red hot, when cold dissolved in distilled water, the excess of potash saturated by nitric acid, and the solution added to one of muriate of baryta; 28 grains of sulphate of baryta were obtained, very nearly equal to 9,6 sulphuric acid; the salt therefore contained twice the quantity of sulphuric acid required to form a neutral sulphate with the potash, or two proportionals.

In order to ascertain the proportions of the remaining elements of the salt, 5 grains were heated with oxide of copper, 5,5 cubic inches of carbonic acid gas, and 1,4 grains of water were collected; several of these experiments were made with similar results; 20 grains of the salt had been found to contain 5,76 potash,

9,60 sulphuric acid.

5 grains therefore must have contained	1,44 potash.
	2,40 sulphuric acid.
5,5 cubic inches carbonic acid gas contain	0,699 carbon.
The water obtained was - - -	1,40.
	5,939 grains.

making an excess over the 5 grains employed of 939 of a grain. If this excess be oxygen furnished to hydrogen to form part of the water obtained, and such a view is confirmed by the loss of weight of the tube and its contents after the operation, it will give of hydrogen 0,1174 of a grain, and of water so formed 1,05 grains; this deducted from the whole quantity of water obtained, leaves 0,35 of a grain water of crystallization; 100 grains would therefore be composed of

Potash -	28,84
Sulphuric acid	48,84
Carbon -	13,98
Hydrogen -	2,34
Water -	7.

These numbers indicate nearly one proportional of potash, two of sulphuric acid, four of carbon and four of hydrogen; and it would appear that in these salts the four proportionals of carbon, with the four of hydrogen, are saturating one of sulphuric acid. I am not able at present to account for the difference between the quantity of water and a proportional number, every precaution having been taken in these experiments to insure accuracy. Several attempts were made to procure an anhydrous salt, but without success, in consequence of the facility with which these acids and other compounds decompose.

The resemblance of these salts to the sulphovinates, induced me to suppose they might be similar in composition, I therefore prepared some sulphovinate of potash. Its crystalline form was the same as that of the salt obtained from oil of wine, and upon examination it proved in all respects similar.

While preparing some of the sulphovinates, I was struck with the very great change produced in sulphuric acid by mere mixture with alcohol.

440 grains of sulphuric acid were mixed with an equal weight of alcohol of specific gravity ,820 ; the mixture when cold was diluted with water and saturated by carbonate of soda, partially dried, of which it required for saturation 398 grains, while 440 grains of sulphuric acid not mixed with alcohol saturated 555 grains of the same carbonate of soda, so that $\frac{2}{7}$ of the acid had been saturated by the alcohol.

440 grains of sulphuric acid mixed with its own weight of alcohol, as before, and then poured into a solution of acetate of lead, 542 grains of sulphate were precipitated. The same quantity of sulphuric acid unchanged by alcohol gave 1313 grains of sulphate of lead; thus $\frac{4}{7}$ of the sulphuric acid had lost its power of precipitating oxide of lead from its solutions ; it had in fact been converted into sulphovinic acid.

M. VOGEL, who has particularly described some of these salts, and I believe also M. GAY LUSSAC, have supposed that this loss of saturating power arises from the formation of hyposulphuric acid, and that the hyposulphates, and sulphovinates, only differ in the latter containing some ethereal oil, which in some way acts the part of water of crystallization. It is evident that the properties of oil of wine cannot be thus explained ; and it appears to me more probable that the power of combination which hydrocarbon is shown to be possessed of in oil of wine, is effective in neutralising half the acid of the salts formed from it, as before described.

It only now remains to examine the hydrocarbon in the states in which it has been obtained separate from its combinations.

When oil of wine is heated in a solution of potash, or if heated in water merely, the excess of hydrocarbon above that necessary to constitute the acid, forming the salts I have described, is liberated in the form of an oil, not unlike in appearance castor oil, having but little fluidity when cold, and in some cases partially crystallizing. When gently heated it is beautifully bright, and of an amber colour; the vapour has an agreeable pungent and aromatic smell; it evaporates at a temperature a little above that of boiling water; burns with a brilliant flame, throwing off some carbon; its specific gravity is about 9, water being 10; it is insoluble in water, very soluble in ether, somewhat less so in alcohol.

Several analytical experiments were made upon this substance with similar results. When decomposed by oxide of copper, 0,72 of a grain gave 4,85 cubic inches of carbonic acid gas and ,85 of a grain of water; 4,85 cubic inches of carbonic acid gas are equal to 0,6164 of a grain of carbon, and the 0,85 of a grain of water to 0,09444 of a grain of hydrogen; 100 parts should therefore be composed of

Carbon 85,61
Hydrogen 13,116.

There is here some trifling loss; if that be supposed to be hydrogen, this oily matter is precisely similar in the proportions of its elements to olefiant gas.

The crystals which spontaneously separate from oil of wine were next examined; they were prismatic, and resembled precisely in all their characters, except their solid form, the fluid substance just described. They fused at a temperature a little above that of boiling water. After purifying a portion by pressing them in blotting paper, to remove

While preparing some of the sulphovinates, I was struck with the very great change produced in sulphuric acid by mere mixture with alcohol.

440 grains of sulphuric acid were mixed with an equal weight of alcohol of specific gravity ,820 ; the mixture when cold was diluted with water and saturated by carbonate of soda, partially dried, of which it required for saturation 398 grains, while 440 grains of sulphuric acid not mixed with alcohol saturated 555 grains of the same carbonate of soda, so that $\frac{2}{7}$ of the acid had been saturated by the alcohol.

440 grains of sulphuric acid mixed with its own weight of alcohol, as before, and then poured into a solution of acetate of lead, 542 grains of sulphate were precipitated. The same quantity of sulphuric acid unchanged by alcohol gave 1313 grains of sulphate of lead; thus $\frac{4}{7}$ of the sulphuric acid had lost its power of precipitating oxide of lead from its solutions; it had in fact been converted into sulphovinic acid.

M. VOGEL, who has particularly described some of these salts, and I believe also M. GAY LUSSAC, have supposed that this loss of saturating power arises from the formation of hyposulphuric acid, and that the hyposulphates, and sulphovinates, only differ in the latter containing some ethereal oil, which in some way acts the part of water of crystallization. It is evident that the properties of oil of wine cannot be thus explained; and it appears to me more probable that the power of combination which hydrocarbon is shown to be possessed of in oil of wine, is effective in neutralising half the acid of the salts formed from it, as before described.

It only now remains to examine the hydrocarbon in the states in which it has been obtained separate from its combinations.

When oil of wine is heated in a solution of potash, or if heated in water merely, the excess of hydrocarbon above that necessary to constitute the acid, forming the salts I have described, is liberated in the form of an oil, not unlike in appearance castor oil, having but little fluidity when cold, and in some cases partially crystallizing. When gently heated it is beautifully bright, and of an amber colour; the vapour has an agreeable pungent and aromatic smell; it evaporates at a temperature a little above that of boiling water; burns with a brilliant flame, throwing off some carbon; its specific gravity is about 9, water being 10; it is insoluble in water, very soluble in ether, somewhat less so in alcohol.

Several analytical experiments were made upon this substance with similar results. When decomposed by oxide of copper, 0,72 of a grain gave 4,85 cubic inches of carbonic acid gas and ,85 of a grain of water; 4,85 cubic inches of carbonic acid gas are equal to 0,6164 of a grain of carbon, and the 0,85 of a grain of water to 0,09444 of a grain of hydrogen; 100 parts should therefore be composed of

Carbon 85,61
Hydrogen 13,116.

There is here some trifling loss; if that be supposed to be hydrogen, this oily matter is precisely similar in the proportions of its elements to olefiant gas.

The crystals which spontaneously separate from oil of wine were next examined; they were prismatic, and resembled precisely in all their characters, except their solid form, the fluid substance just described. They fused at a temperature a little above that of boiling water. After purifying a portion by pressing them in blotting paper, to remove

any adhering oil of wine, several experiments were made upon quantities of a grain each; 6,46 cubic inches of carbonic acid gas and 1,21 grains of water were obtained; the 6,46 cubic inches of carbonic acid equal ,82106 of a grain of carbon, and the 1,21 grains of water equal ,13444 of a grain of hydrogen.

The carbon and hydrogen are here very nearly in single proportionals, but there is great loss, I believe: this may be partly attributed to oil of wine still adhering, but of that I am not at present able to satisfy myself, my stock of crystals being exhausted.

On mentioning these results to Mr. FARADAY, he gave me some sulphuric acid which had been exposed to olefiant gas, during some of his experiments on the products of the decomposition of oil by heat. It had absorbed about 80 times its volume of the gas, acquired a deep brown colour, and a smell resembling oil of wine. It was saturated by carbonate of potash carefully evaporated to dryness, and the dry mass digested in alcohol. A small quantity of a salt was obtained from the alcoholic solution having the crystalline form and general characters of the salts I have been describing.

Thus it would appear that hydrocarbon constituted of single proportionals, or 6 carbon and 1 hydrogen by weight has the power of combining with sulphuric acid; and that whether it be evolved and then combined, as in the case of olefiant gas, or its elements separated from other compounds, as from alcohol, it forms precisely the same combination, sulphovinic acid. It further appears, that oil of wine is a perfectly neutral compound of sulphuric acid and hydrocarbon, and that it is resolvable by various processes into sulphovinic acid, during

which it loses hydrocarbon, and acquires a saturating power equivalent to only half the natural power of the sulphuric acid it contains. The remaining hydrocarbon enters with it into saline combinations, and is there equivalent in saturating power to the quantity of base taken up. The proportions of hydrocarbon which in this way replaces bases being four proportionals, or 24 carbon, 4 hydrogen.

XVIII. *On a method of expressing by signs the action of machinery.* *By* CHARLES BABBAGE, *Esq. F. R. S. Communicated January* 17, 1826.

Read March 16, 1826.

IN the construction of an engine, on which I have now been for some time occupied, for the purpose of calculating tables and impressing the results on plates of copper, I experienced great delay and inconvenience from the difficulty of ascertaining from the drawings the state of motion or rest of any individual part at any given instant of time: and if it became necessary to enquire into the state of several parts at the same moment the labour was much encreased.

In the description of machinery by means of drawings, it is only possible to represent an engine in one particular state of its action. If indeed it is very simple in its operations, a succession of drawings may be made of it in each state of its progress which will represent its whole course; but this rarely happens, and is attended with the inconvenience and expence of numerous drawings. The difficulty of retaining in the mind all the cotemporaneous and successive movements of a complicated machine, and the still greater difficulty of properly timing movements which had already been provided for, induced me to seek for some method by which I might at a glance of the eye select any particular part, and find at any given time its state of motion or rest, its relation to the motions of any other part of the machine, and if

necessary trace back the sources of its movement through all its successive stages to the original moving power. I soon felt that the forms of ordinary language were far too diffuse to admit of any expectation of removing the difficulty, and being convinced from experience of the vast power which analysis derives from the great condensation of meaning in the language it employs, I was not long in deciding that the most favourable path to pursue was to have recourse to the language of signs. It then became necessary to contrive a notation which ought if possible to be at once simple and expressive, easily understood at the commencement, and capable of being readily retained in the memory from the proper adaptation of the signs to the circumstances they were intended to represent. The first thing to be done was obviously to make an accurate enumeration of all the moving parts, and to appropriate a name to each; the multitude of different contrivances in various machinery, precluded all idea of substituting signs for these parts. They were therefore written down in succession, only observing to preserve such an order that those which jointly concur for accomplishing the effect of any separate part of the machine might be found situated near to each other: thus in a clock, those parts which belong to the striking part ought to be placed together, whilst those by which the repeating part operates ought, although kept distinct, yet to be as a whole, adjacent to the former part.

Each of these names is attached to a faint line which runs longitudinally down the page, and which may for the sake of reference be called its *indicating line*.

The next object was to connect the notation with the

drawings of the machine, in order that the two might mutually illustrate and explain each other.

It is convenient in the three representations of a machine, to employ the same letters for each part; in order to connect these with the notations, the letters which in the several drawings refer to the same parts, are placed upon the indicating lines immediately under the names of the things. If circumstances should prevent us from adhering to this rule, it would be desirable to mark those things represented in the plan by the ordinary letters of the alphabet, those pointed out for one of the other projections by the letters of an accented alphabet, and the parts delineated on the third projection by a doubly accented alphabet. In engines of so complicated a nature as to require sections at various parts as well as the three projections, this system is equally applicable, and its advantage consists in this—that the number of accents on the letter indicates at once the number of the drawing on which it appears, and when it is intended to refer to several at the same time, the requisite letters may be employed and placed in the order in which the drawings will best illustrate the part under examination.

The next circumstance which can be indicated by the system of mechanical notation which I propose, more readily than by drawings, is the number of teeth on each wheel or sector, or the number of pins or studs on any revolving barrel. A line immediately succeeding that which contains the references to the drawings is devoted to this purpose, and on each vertical line indicating any particular part of the machine, is written the number of teeth belonging to it. As there is generally a great variety of parts of machinery which

do not consist of teeth; of course every vertical line will not have a number attached to it.

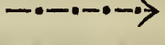
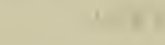
The three lines immediately succeeding this, are devoted to the indication of the velocities of the several parts of the machine. The first must have, on the indicating line of all those parts which have a rectilinear motion, numbers expressing the velocity with which those parts move, and if this velocity is variable, two numbers should be written, one expressing the greatest, the other the least velocity of the part. The second line must have numbers expressing the angular velocity of all those parts which revolve; the time of revoluion of some one of them being taken as the unit of the measure of angular velocity.

It sometimes happens that two wheels have the same angular velocity when they move; but from the structure of the machine, one of them rests one half of the time during which the other is in action. In this case, although their angular velocities are equal, their comparative velocities are as 1 to 2; for the second wheel makes two revolutions, whilst the other only makes one. A line is devoted to the numbers which thus arise, and it is entitled, Comparative Angular Velocity.

The next object to be considered is the course through which the moving power is transmitted, and the particular modes by which each part derives its movement from that immediately preceding it in the order of action. The sign which I have chosen to indicate this transmission of motion (an arrow), is one very generally employed to denote the direction of motion in mechanical drawings; it will therefore readily suggest the direction in which the movement is transmitted. There are however various ways by which

motion is communicated; and it becomes a matter of some importance to consider whether, without interfering with the sign just selected, some modification might not be introduced into its minor parts, which, leaving it unaltered in the general form, should yet indicate the peculiar nature of the means by which the movement is accomplished.

On enumerating those modes in which motion is usually communicated, it appeared that they may be reduced to the following.

One piece may receive its motion from another by being permanently attached to it as a pin on a wheel, or a wheel and pinion on the same axis.	This may be indicated by an arrow with a bar at the end.
One piece may be driven by another in such a manner that when the driver moves, the other also always moves; as happens when a wheel is driven by a pinion.	An arrow without any bar.
One thing may be attached to another by stiff friction.	An arrow formed of a line interrupted by dots. 
One piece may be driven by another, and yet not always move when the latter moves; as is the case when a stud lifts a bolt once in the course of its revolution.	By an arrow, the first half of which is a full line, and the second half a dotted one.
One wheel may be connected with another by a ratchet, as the great wheel of a clock is attached to the fusee.	By a dotted arrow with a ratchet tooth at its end. 

Each of the vertical lines, representing any part of the machine, must now be connected with that representing the part from which it receives its movement, by an arrow of such a kind as the preceding table indicates; and if any part derives motion from two or more sources, it must be connected by the proper arrows with each origin of its movement. It will in some cases contribute to the better understanding of the machine, if those parts which derive movement from two or more sources have their names connected by a bracket, with two or more vertical lines, which may be employed to indicate the different motions separately. Thus if a shaft has a circular as well as a longitudinal motion, the two lines attached to its name should be characterised by a distinguishing mark, such as (vert. motion) and (circ. motion). Whenever any two or more motions take place at the same time, this is essential; and when they do not, it is convenient for the purpose of distinguishing them.

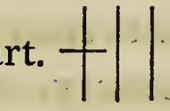
All machines require, after their parts are finished and put together, certain alterations which are called adjustments. Some of these are permanent, and, when once fixed by the maker, require no further care. Others depend on the nature of the work they are intended to perform, as in the instance of a corn mill; the distance between the stones is altered according to the fineness of the flour to be ground: these may be called usual adjustments; whilst there are others depending on the winding up of a weight, or spring, which may be called periodic adjustments. As it is very desirable to know all the adjustments of a machine, a space is reserved, below that in which the connections of the moving parts are exhibited, where these may be indicated; if there are many

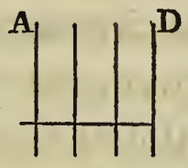
adjustments, this space may be subdivided into three, and appropriated to each of the three species just enumerated, the permanent, the usual, and the periodic: if their number is small, it is better merely to distinguish them by a modification of their signs. It is sometimes impossible to perform such adjustment, except in a particular succession; and it is always convenient to adhere to one particular order. Numbers attached to their respective lines denote the order in which the parts are to be adjusted; and as it will sometimes happen that two or more adjustments must be made at the same time, in that case the same numbers must be written on the lines belonging to all those parts which it is necessary to adjust simultaneously.

If it is convenient to distinguish between the species of adjustments without separating them by lines, this may be accomplished by putting a line above or below the figures, or inclosing them in a circle, or by some similar mode. I have attached the letter P to those which are periodic.

It would add to the knowlege thus conveyed, if the sign indicating adjustment also gave us some information respecting its nature; there are, however, so many different species, that it is perhaps better in the first instance to confine ourselves to a few of the most common, and to leave to those whom may have occasion to employ this kind of notation, the contrivance of signs, fitted for their more immediate purpose.

One of the most common adjustments is that of determining the distance between two parts, as between the point of suspension and the centre of oscillation of a pendulum. This might be indicated by a small line crossing the vertical

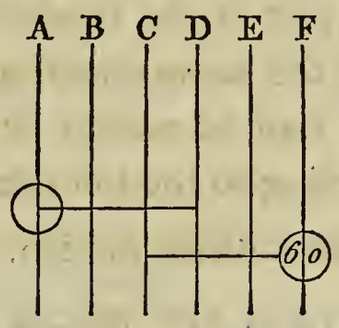
line attached to the part.  If the distance between two parts, which are represented by different lines, is to be altered, their lines may be connected by an horizontal line.



Thus the adjustment of A in the above figure depends on its distance from D.

This adjustment often determines the length of a stroke, and sometimes the eccentricity of an eccentric, which depends on the linear distance between its centre and its centre of motion.

The next most frequently occurring adjustment is that which is sometimes necessary in fixing two wheels, or a wheel and an arm on the same axis. This relation of angular position, may be indicated by a circle and two radii placed at the requisite angle, or that angle may be stated in figures and inclosed within the circle; this circle ought however to be connected by a line with the other part, with which the angle is to be formed, thus,



which means that an adjustment is to be made by fixing A on its axis, making a right angle with D, and that F must also make with C an angle of sixty degrees. In speaking of these angles, it should always be observed that they refer to the angles made by the parts on one of the planes of projection.

When it is thought requisite to enter into this minute detail of adjustments, it will be necessary, in order to avoid confusion, to put the lines indicating the order of adjustment, above and distinct from these signs.

The last and most essential circumstance to be represented, is the succession of the movements which take place in the working of the machine. Almost all machinery, after a certain number of successive operations, recommences the same course which it had just completed, and the work which it performs usually consists of a multitude of repetitions of the same course of particular motions.

It is one of the great objects of the notation I am now explaining, to point out a method by which, at any instant of time in this course or cycle of operations of any machine, we may know the state of motion or rest of every particular part; to present a picture by which we may, on inspection, see not only the motion at that moment of time, but the whole history of its movements, as well as that of all the cotemporaneous changes from the beginning of the cycle.

In order to accomplish this, each of the vertical indicating lines representing any part of the machine, has, adjacent to it, other lines drawn in the same direction: these accompanying lines denote the state of motion or rest of the part to which they refer, according to the following rules.

1. Unbroken lines indicate motion.
2. Lines on the right side indicate that the motion is from right to left.
3. Lines on the left side indicate that the direction of the motion is from left to right.

4. If the movements are such as not to admit of this distinction, then when lines are drawn adjacent to an indicating line, and on opposite sides of it, they signify motions in opposite directions.

5. Parallel straight lines denote uniform motion.

6. Curved lines denote a variable velocity. It is convenient as far as possible to make the ordinates of the curve proportional to the different velocities.

7. If the motion may be greater or less within certain limits: then if the motion begin at a fixed moment of time, and it is uncertain when it will terminate, the line denoting motion must extend from one limit to the other, and must be connected by a small cross line at its commencement with the indicating line. If the beginning of its motion is uncertain, but its end determined, then the cross line must be at its termination. If the commencement and the termination of any motion are both uncertain, the line representing motion must be connected with the indicating line in the middle by a cross line.

8. Dotted lines imply rest. It is convenient sometimes to denote a state of rest by the absence of any line whatever.

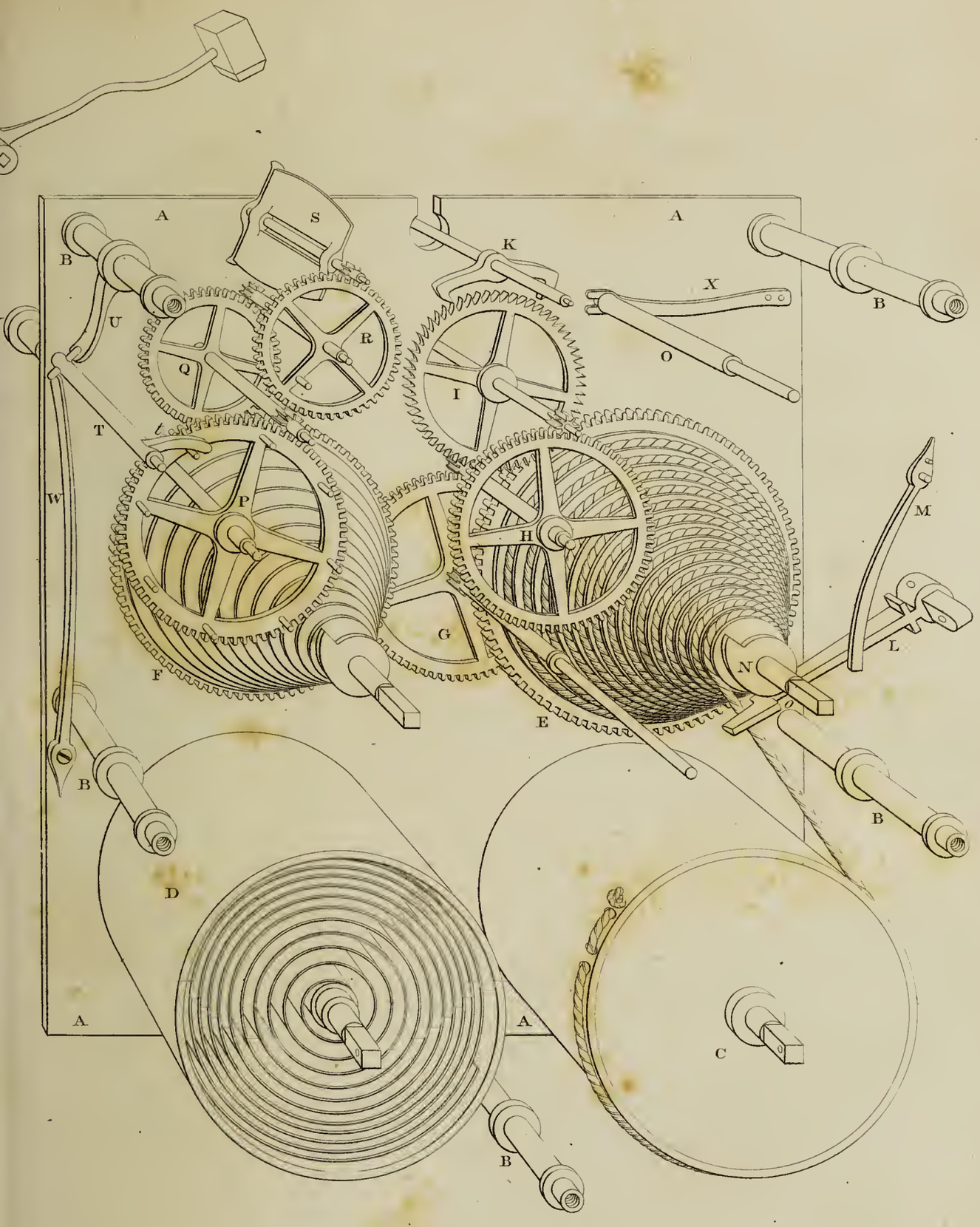
9. If the thing indicated be a click, bolt, or valve, its dotted line should be on the right side if it is out of action, unbolted, or open, and on the left side if the reverse is the case.

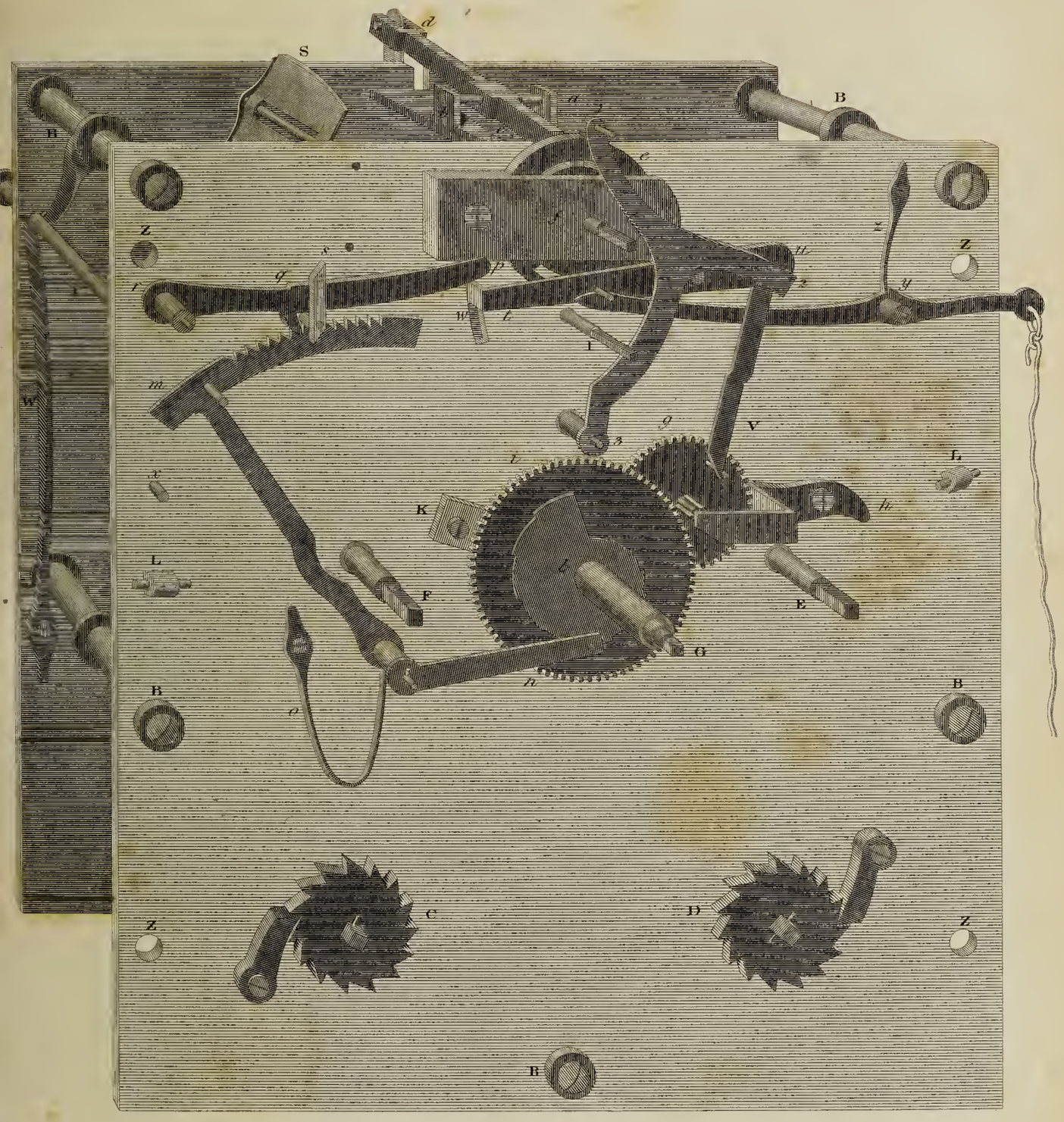
10. If a bolt may rest in three positions: 1st, bolted on the right side; 2nd, unbolted; 3rd, bolted on the left side. When it is unbolted, and in the middle station, use two lines whilst in the act of unbolting, and two lines of dots, one on each side of, and close to the indicating line, whilst it rests in this position. When it is bolted on the right side, a line or a line of dots at a greater distance on the right hand from the indicating line will represent it. And if it is bolted on the left, a similar mode of denoting it must be used on that side. Any explanation may, if required, be put in words at the end of the notation, as will be observed in that of the hydraulic ram, Plate IV.

I have now explained means of denoting by signs almost all those circumstances which usually occur in the motion of machinery: if other modifications of movement should present themselves, it will not be difficult for any one who has rendered himself familiar with the symbols employed in this Paper, to contrive others adapted to the new combinations which may present themselves.

The two machines which I have selected as illustrations of the application of this method, are, the common eight day clock, and the hydraulic ram. The former was made choice of from its construction being very generally known, and I was induced to choose the latter from the apparent difficulty of applying this method to its operations.

The advantages which appear to result from the employment of this *mechanical notation*, are to render the description of machinery considerably shorter than it can be when ex-


A
S
B
U
R
Q
T
t
W
P
F
G
A
K
X
O
I
H
M
L
N
E
B
D
C
A
A
B
B
B



E. Turrell. sculp.

E. Beyrel. sc.

VALVES

SIGNS

NO. OF TEETH

LINEAR VELOCITY

ANGULAR VELOCITY

COMPd VELOCITY

ORIGIN OF MOTION

ADJUST-MENTS

TIME

TIME PART — Revenant — Idem

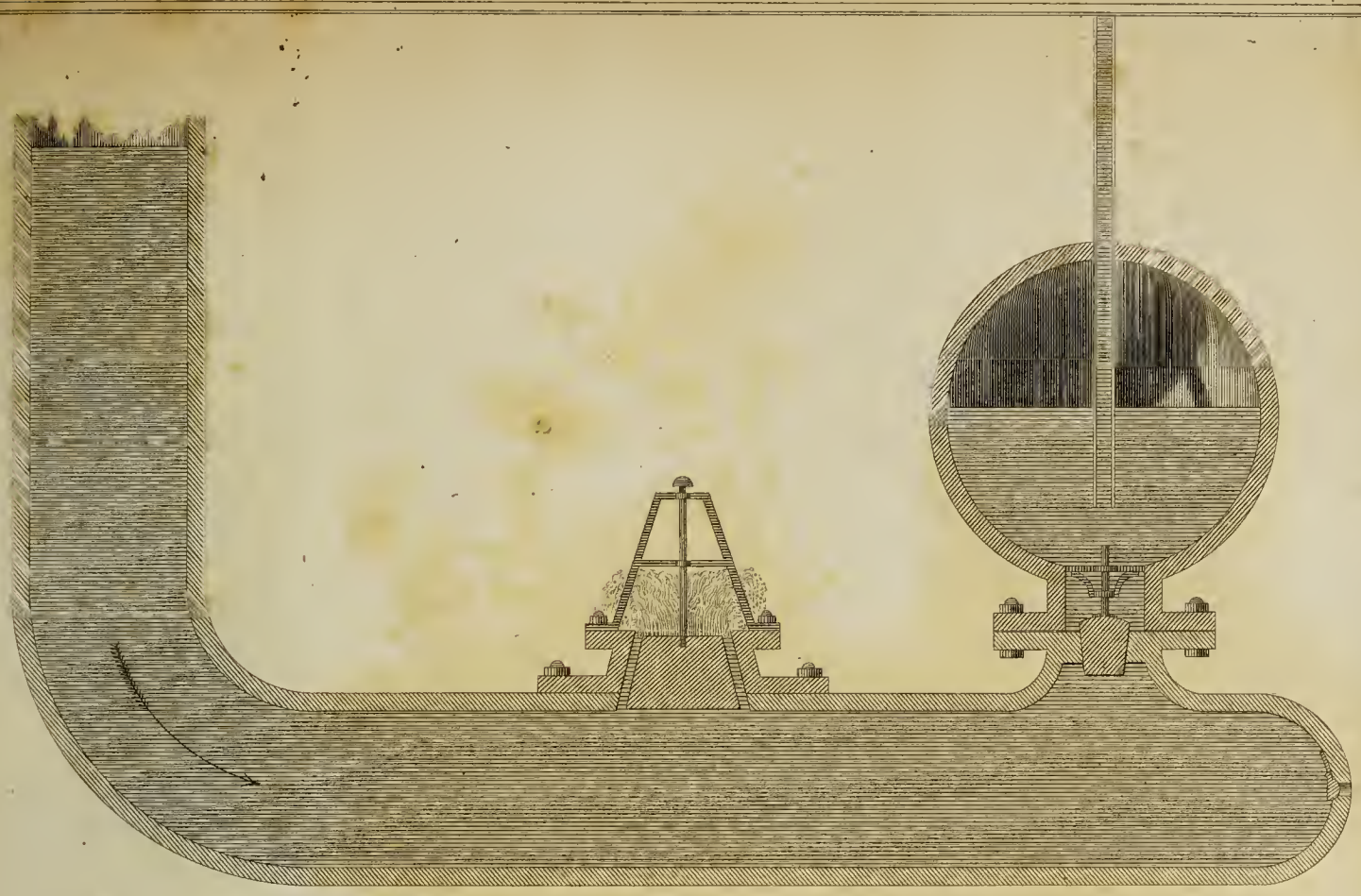
REVOLVING PART — and — STRIKING PART

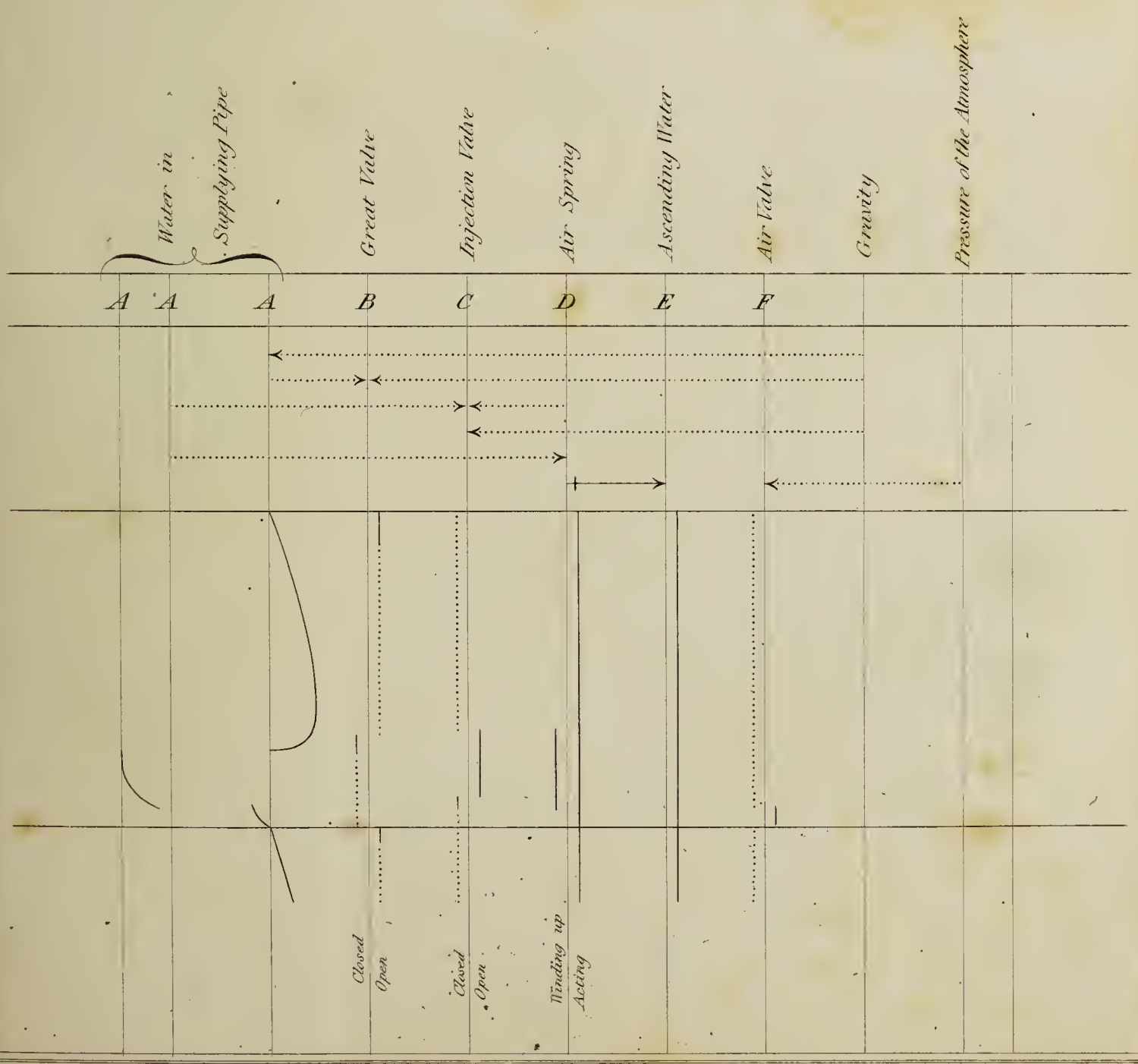
Carving
Pendulum
Crutch
Pallet a)
Pallet b)
Escapement or 3re Wheel
Pinion on Axis
3re Wheel
Pinion on Arbor
Centre or Hour Wheel
Pinion on Hour Wheel
Great Wheel
Fusee
Barrel for main Spring
Chain pinion
Plain of repeat
Small pinion on Ad
12 hour Wheel
Fin or Pinion of Report
Snail or 12 hour Wheel
Hour hand
Minute hand
Seconds hand

Arbor of warning Fuse
Flimmer
Pinion on Arbs of Ad
Cross Wheel
Fin or cross Wheel
Pinion on Ad
Tumbler Wheel
Pinion of Ad
Fin Wheel
Pins on Ad
Pinion to Ad
Fusee Wheel
Striking Fusee
Striking spring
Arbor moving hammer to bell
Cross-piece
Rack
Rack-tail
Rack-tail Spring
Hawks bill
Catherine pallet
Warning piece

P2

P1




Water in Supplying Pipe
Great Valve
Injection Valve
Air Spring
Ascending Water
Air Valve
Gravity
Pressure of the Atmosphere
A A A B C D E F
Closed
Open
Closed
Open
Winding up
Acting

E. Turrell. sc.

pressed in words. The signs, if they have been properly chosen, and if they should be generally adopted, will form as it were an universal language; and to those who become skilful in their use, they will supply the means of writing down at sight even the most complicated machine, and of understanding the order and succession of the movements of any engine of which they possess the drawings and the mechanical notation. In contriving machinery, in which it is necessary that numerous wheels and levers, deriving their motion from distant parts of the engine, should concur at some instant of time, or in some precise order, for the proper performance of a particular operation, it furnishes most important assistance; and I have myself experienced the advantages of its application to my own calculating engine, when all other methods appeared nearly hopeless.

DESCRIPTION OF THE PLATES.

Plates VII. and VIII. are different representations of an eight day clock, for the purpose of comparing it with the notation.

Plate IX. represents the mechanical notation of the same clock.

Under the names of each part follow the letters which distinguish them in the plates.

The next line contains numbers which mark the number of teeth in each wheel, pinion, or sector.

The following line is intended to contain numbers expressing the linear velocity of the different parts: in the eight day clock this line is vacant, because almost all the motions are circular.

The next line indicates the angular velocity of each part;

and in order to render the velocity of the striking parts comparable with those of the time part, I have supposed one revolution of the striking fusee to be made in one minute: I have also taken one revolution of the scapement wheel, or one minute of time as the unit of angular velocity.

The space entitled comparative angular velocity, expresses the number of revolutions one wheel makes during one revolution of some other; it differs from the real angular velocity, because one wheel may be at rest during part of the time. Thus the clock strikes 78 strokes during twelve hours, or one revolution of the hour hand: if this be called unity, the pin wheel moves through 78 pins or $9\frac{3}{4}$ revolutions in the same time; its comparative angular velocity is therefore $9\frac{3}{4}$.

The space in which the origin of motion is given, will not require any explanation after reading the description of the signs employed in this paper.

The adjustments are numbered in the order in which they are to be made. No. 1, is attached to the crutch: the first adjustment is to set the clock in beat. No. 2, is to adjust the length of the pendulum to beat seconds. No. 3, occurs in three different places, at the hour and minute hands, and at the snail on the hour wheel. It is necessary that when the hour hand is at a given figure, three o'clock for instance, that the minute hand should be set to twelve o'clock; it is also necessary that the snail should be in such a position that the clock may strike three. These adjustments must be made at the same time. No. 4, is for the adjustment of the seconds hand to 60 seconds. No. 5, is double, and is for the adjustment of the minute and hour hand to the next whole

minute to that which is indicated by the watch by which the clock is set. No. 6, is for the pendulum, which must be held aside at its extreme arc until the instant at which the watch reaches the time set on the face of the clock; it must then be set free.

The remaining part of the notation indicates the action of every part at all times; but as the whole cycle of twelve hours would occupy too much space, a portion only is given about the hour of four: from this the machine may be sufficiently understood. As an instance of its use, let us enquire what movements are taking place at seven seconds after four o'clock. On looking down on the left hand side to the time just mentioned, we observe between the end of the sixth, and end of the seventh second, that the pendulum and crutch begin to move from the right to the left, increasing their velocity to a maximum, and then diminishing it; that the whole train of wheels of the time part are at rest during the greater part of that second, and all move simultaneously a little before its termination. The greater part of the train of the striking part is moving uniformly; but two parts the cross piece, and the other moving the hammer, being at the commencement of this second in a state of motion from right to left, suddenly have that motion reversed for a short time: this is at the moment of striking: two other pieces, the hawk's bill, and the gathering pallet, appears to act at the same moment.

If the course of movement of any one part is required throughout the whole cycle of the machine's action, we have only to follow its indicating line. If it is required to find what motions take place at the same time, we have only to look along the horizontal line marked by the time specified.

Let us now enquire into the source of motion of the minute hand. On looking down to the space in which the origin of motion is given, we observe an arrow point, which conveys us to the

Cannon pinion, with which it is connected permanently.

The cannon pinion is driven by the centre or hour wheel, with which it is connected by stiff friction.

The hour wheel is driven by its pinion, to which it is permanently attached.

The hour wheel pinion is driven by the great wheel, into which it works.

The great wheel is driven by the fusee, with which it is connected by a ratchet.

The fusee is driven by the spring barrel or main spring, which is the origin of all the movements.

When that part of the notation which relates to the successive movements of the machine is of considerable extent, it is convenient to write on a separate piece of paper the names of every part, at the same distances from each other as the indicating lines, and exactly as they are placed at the top. By sliding this paper down the page to any part which is under consideration, the trouble of continual reference to the top of the drawing will be avoided.

Plate X. represents the hydraulic ram; its mechanical notation is added below it.

A, is the supplying pipe.

B, is the great valve.

C, the valve into the air vessel.

D, the air vessel.

E, the ascending water.

F, the small air valve:—its office is to supply a small

quantity of air at each stroke ; it opens when the valve C is just closed, and a regurgitation takes place in the supplying pipe just previous to the opening of the great valve. Without this contrivance, the pressure on the air in the air vessel would cause it to be soon absorbed by the water, and the engine would cease to act.

In this notation two indicating lines A, A, are allowed to the supplying water, because it takes three different courses during the action of the machine. The first of these marks the time of its motion when it enters the air vessel, and the second indicates its course when passing through the great valve, and also its course when, owing to the elasticity of the materials, its motion is for an instant reversed, at which moment air is taken in at the air valve F.

The action of the machine is as follows : the supplying water rushing along the great pipe passes out at the great valve ; it acquires velocity until the pressure of the effluent water against the under part of the great valve causes it to close suddenly. At this moment the whole momentum of the water is directed against the sides of the machine, and the air valve being the weakest part gives way, and admits a small quantity of water ; the air spring soon resists sufficiently to close the air valve : at this moment the elasticity of the apparatus re-acting on the water in the great pipe, drives it back for an instant, during which the pressure of the atmosphere opens the air valve, and a small quantity of air enters ; this finds its way to the air chambers, which easily discharges it through the ascending pipe if too much air has entered.

XIX. *On the parallax of the fixed stars.* *By* J. F. W. Herschel, *Esq. M. A. Sec. R. S. Communicated January* 19, 1826.

Read March 9 and 16, 1826.

The determination of the existence and amount of annual parallax in the fixed stars, was the object which originally drew the attention of astronomers to the examination and measurement of double stars, upon a principle suggested originally by Galileo, and improved on and more fully developed by my Father in one of his earliest communications to the Royal Society, Phil. Trans. 1782 ; according to which, two stars placed very nearly in a line with each other and with our system, ought, if situated at very different distances, in the line of sight, to be subject to periodical variations in their apparent distance from each other, according as the earth in its annual motion approaches to or recedes from that point in the plane of the ecliptic, where the line joining them, prolonged, would meet it. The difficulty of determining the distance of two stars of a double star with the necessary degree of exactness for this delicate purpose, has however hitherto put a stop to this enquiry ; and, as it is now rendered extremely probable that the parallax at least of the generality of stars is much below 1″, must continue to do so, until some very great improvement of micrometers shall enable us to measure tenths of seconds with as great certainty as we at present can units.

I do not find that it has been noticed, however, that parallax

must occasion a periodical change in the angle of position, as well as in the distance of the two stars composing a double star, and that this variation is much more susceptible of ready and exact appreciation with our present micrometers than that of their distance. To render this sensible, we need only remark, that the effect of parallax is to cause each star to describe (apparently) a small ellipse in the heavens, the major axis of which is parallel to the ecliptic, and the minor in the direction of a secondary to that great circle, the true place of the stars being in the centre. Were these ellipses of the same magnitude, for each of two contiguous stars, the line joining their apparent places (which are necessarily homologous points in the circumferences of each) would preserve its parallelism at all times; but as the axes of the ellipses are reciprocally as the distances of the stars, that parallelism cannot obtain when the stars are situated at very unequal distances from the earth, and an alternate increase and decrease of the angle of position made by this line with any fixed direction must be the necessary consequence.

To estimate the extent of this variation, let us conceive two stars so situated as to have their apparent line of junction in the direction of a secondary to the ecliptic, and therefore at right angles to the major axes of their parallactic ellipses—let their distances from us be such that the nearer one shall have a parallax of $1''$, and the farther no appreciable amount of it. Also, let their apparent angular distance from each other be $5''$. It is evident that the variation alluded to will equal the angle subtended by a line of $1''$ in length, at a point $5''$ distant from its middle, that is, to $11^\circ\ 25'$.

Now this is a quantity which is quite beyond all conceivable limits of error of observation in the measurement of double

stars, and for stars nearer than 5″ the amount is of course proportionally greater. Thus for two stars, at only 1″ distance from each other, of which the one is affected by parallax to the amount of 1″, and the other not all, the annual variation in position will amount to upwards of 53°.

When the distance between two stars amounts to no more than 3″, and in many cases even when they are still nearer, Mr. SOUTH's and my own experience in the use of the position micrometer, as well as Mr. STRUVE's numerous and excellent measures recorded in the Dorpat Observations, lead me to believe that a single degree in the angle of position is a quantity distinctly appreciable in the mean of several sets of measures carefully taken on different nights of observation, even when a considerable inequality in the stars, or other unfavourable circumstances exist; and were observations continued for a series of years at the proper times, and made with the care so delicate a subject of research would peculiarly call for, there can be no doubt that a greater degree of precision might be obtained; and it certainly seems not too much to assume, that half that quantity, or 30′ of variation in the angle of position, *if regularly periodical*, must ultimately be detected. This conclusion appears warranted by the interesting re-examination by Mr. SOUTH of stars pointed out in our joint paper on Double Stars (Ph. Tr. 1824. iii.) as having probably a relative angular motion, or as otherwise remarkable, lately communicated by him to the Royal Society, (See Part i. of the present vol.) in which we find instances of coincidence between calculated and computed motions falling within the limit assumed at the outset—too frequent, and too remarkable to be the effect of mere accident.

Now, the tangent of 30′ to a radius of 3″ corresponds to a

subtense of 0″.026, or $\frac{1}{40}$th of a second, so that a difference of parallaxes to the amount of a 40th of a second, existing in the two stars of a double star so circumstanced, could scarcely escape detection; and that even much less quantities than this, under favourable circumstances, might be rendered sensible, I think may fairly be concluded, when we consider that in this estimate, the data are certainly assumed within bounds. No account is here taken of the improvements in the position micrometer, which may reasonably be expected, because the object at present is only to appreciate the degree of delicacy which the method now proposed may lay claim to, with our present instruments and habits of observing, and to compare it with those which have hitherto been resorted to in the investigation of parallax.

In selecting stars for examination, it appears to me that we ought by no means to confine ourselves, by assuming it as a universal law that the brightest stars are the nearest to us. From what we know of the variety of nature and the enormous differences in point of magnitude between the bodies of our own system, it seems improbable that the real magnitude and brightness of the stars should be confined within narrow limits. Their distances are equally undetermined; nor have we any reason whatever to conceive these two elements related to each other. There is not therefore the slightest *a priori* improbability, in supposing that among stars of apparently equal lustre, the greatest diversity of distance may exist, or that innumerable of the minutest stars visible in telescopes may be nearer to us than any of those of the first magnitude; and consequently, that that delicate element in search of which astronomers have exhausted

refinement, may with nearly or quite equal probability of success be sought among stars of far inferior magnitudes. The proper motions of the stars afford an argument from analogy—they bear no relation to their apparent lustre, and by far the greatest proper motions known belong to stars low in the scale of magnitudes.

If these remarks have any foundation, it must be obvious that we ought not to be deterred from the research of parallax by the smallness of the stars composing a double star, or their approach to equality. However, we should except here stars in, or very near the milky way, below the 7th or 8th magnitudes, because the probable *laminar* form of this great sidereal stratum affords a presumption almost amounting to certainty, that minuteness is *here, on the average*, an effect of distance. But, on the other hand, such large stars as β Orionis, which are situated in, or near the borders of the milky way, with small ones near enough to constitute them double stars, have an additional claim to examination, from the additional probability thus afforded of being favourably placed for the detection of parallax: and moreover, this consideration affords plausible grounds for a belief, that, in situations remote from the milky way, minuteness, *on the average*, is *not* the effect of distance.

It is hardly necessary to insist on the great advantages presented by the method here proposed, in its complete exemption from those instrumental errors depending on unsteadiness, erroneous graduation, and expansion, and from all that uncertainty on the score of refraction, and any doubts still remaining as to the magnitudes of the constants of aberration, nutation, &c., which so much embarrass astronomers.

A good telescope and a good micrometer are all the instruments required. This advantage is really incalculable. Instead of confining our attention to one or two principal stars, it puts an almost unlimited range of objects in our power, by enabling us to employ in this research the largest telescopes, and thus easily obtain measures of those stars, which, from their faintness, must present insuperable difficulties with instruments of ordinary apertures.

In selecting objects for examination by this method, we must be chiefly guided by their angles of position and distances. Taking such whose distances are below 15″, (which, on the supposition of $\frac{1}{2}^{\circ}$ periodical variation of position, corresponds to $\frac{1}{8}$ of a second of relative parallax in stars properly situated), the angle of position ought to be such, that the line joining the two stars shall point as nearly as may be, to the pole of the ecliptic. Ten, twenty, or even thirty degrees of deviation either way from this direction, will however not materially vitiate the application of this method to stars near the ecliptic, while, for such as have considerable latitudes, proportionally greater deviations may be allowed, and within thirty degrees of the pole of the ecliptic this element is of comparatively small moment.

In general, to ascertain whether any double star is or is not favourably situated for the application of this method, we must (if we would take up the problem on strict mathematical grounds), proceed as follows:

Let l represent the longitude, and $+\lambda$ the N. latitude of the star, σ its *angle of situation*,* or the angle included at the

* This angle in many astronomical books is called the angle of position, but as in speaking of double stars we have always hitherto called the angle made by the

star by great circles joining it and the north poles of the equinoctial and ecliptic respectively, σ being considered positive for stars in the western hemisphere (or that whose pole is the point ♈), and negative for stars in the eastern, whose pole is ♎. Let also ☉ represent the sun's longitude at any time, and call a the maximum semi-annual parallax or the angle (expressed in seconds), which the radius of the earth's orbit would subtend if perpendicularly presented to an eye at the distance of the star. It is obvious then that a will represent the major semi-axis of the star's parallactic ellipse, and a . sin. λ the minor, so that its excentricity $= \sqrt{a^2 - a^2 . \sin.\lambda^2}$ $= a$. cos. λ, which if we call ae, we have $e = \cos.\lambda$. The star will appear to describe this ellipse in the direction *npsf*. Its motion in it will however not be uniform, but equal areas will be described in equal times about its centre (or the star's mean place): this is evident, because the area described by the star in the parallactic ellipse round its centre is the orthographic projection on the surface of the heavens of that described by the earth round the sun in its orbit. This consideration gives us at once, the equation

$$\tan.\theta = -\sin.l . \operatorname{cotan.}(\odot - l); \qquad (1)$$

where θ represents the elongation of the star in its ellipse from the eastern extremity of its major axis reckoned in the direction *npsf*.

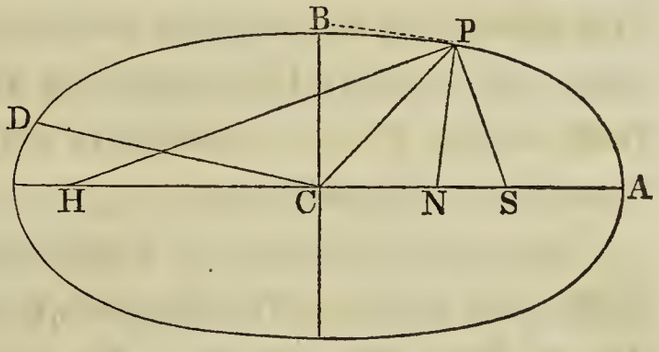
Let π be the angle of position of the small star, π being reckoned from a parallel to the equinoctial, in the same direction *npsf* and from the east, so that the *nf* quadrant shall

line joining the two stars with the parallel, by this name, it becomes necessary to distinguish them, and the expression used in the text is perhaps also more correct than that in common use.

correspond to values of π between 0 and 90°, the *np* to values between 90° and 180° and so on. It is evident, then, that when the large star is in the point of its apparent orbit immediately in the line joining the mean places of both, its elongation, or the value of θ corresponding to this situation will be $\pi - \sigma$.

Since it is only the difference of parallaxes which this method can render sensible, we may suppose the small star a fixed point, and since the dimensions of the parallactic ellipse may be supposed small in comparison with the distance of the small star, two tangents drawn from the latter to the circumference of the former, and which, of course, mark the situation of the large one in its apparent orbit where parallax has the greatest effects in opposite senses on the angle of position, will nearly meet it in the two extremities of a diameter conjugate to that passing through the small star.

To determine the direction of the conjugate diameter, we must have recourse to the general equations of the ellipse from its centre with polar co-ordinates. Thus r being the length of any semi-diameter CP, whose angle of elongation from CA, is $ACP = \varphi$ and r', that of its semiconjugate CD, the angle ACD being called φ', we have, H and S being the foci, and calling CN the abscissa from the centre, x, by a property of the conic sections,



$SP = a - ex = a - er\cos.\varphi$; $HP = a + ex = a + er.\cos.\varphi$;

whence, $SP.HP = CD^2 = r'^2 = a^2 - e^2r^2.\cos.\varphi^2$.

But we have also, $r^2 = \frac{a^2(1-e^2)}{1-e^2.\cos.\varphi^2}$; $r'^2 = \frac{a^2(1-e^2)}{1-e^2.\cos.\varphi'^2}$.

Eliminating from these three equations, r and r', we get the relation required between φ and φ', viz.

$$\text{cos. } \varphi'^2 = \frac{\text{sin. } \varphi^2}{1-(2-e^2)\, e^2 .\, \text{cos. } \varphi^2}$$

This equation will however be reduced to a much more convenient form for our present purpose by a transformation, viz.

$$\text{tan. } \varphi'^2 = \frac{\text{sin. } \varphi'^2}{\text{cos. } \varphi'^2} = \frac{1-\text{cos. } \varphi'^2}{\text{cos. } \varphi'^2}$$

$$= \frac{(1-e^2)^2 .\, \text{cos. } \varphi^2}{\text{sin. } \varphi^2}$$

that is simply

$$-\text{tan. } \varphi' = (1-e^2) .\, \text{cot. } \varphi$$

the sign — being prefixed in extracting the root, became in the ellipse C P and C D lie in different quadrants. Now in the case before us we have

$$\varphi = \pi - \sigma \text{ and } \varphi' = \theta \text{; so that}$$

$$\text{tan. } \theta = -(1-e^2) .\, \text{cotan. } (\pi - \sigma)$$

But $(1-e^2) = \text{sin. } \lambda^2$, and by equation (1) $-\text{tan. } \theta = \text{sin. } l .$ cotan. $(\odot - l)$. Hence substituting, we get

$$\text{sin. } \lambda^2 .\, \text{tan. } (\odot - l) = \text{sin. } l .\, \text{tan. } (\pi - \sigma); \qquad (2)$$

This equation gives at once the value of $\odot$ the sun's longitude, and therefore (by consulting an ephemeris) the time of year sought, by an exceedingly simple process adapted to logarithmic computation.

The actual advantage or disadvantage in point of situation in the case of any particular star, is expressed by the magnitude of the whole change in the angle of position produced by parallax, *i. e.* by the angle subtended by the ellipse at the small star, or, (calling the distance of the latter from its centre δ) on the original supposition of the whole effect being small, by the expression $P = \frac{2r'}{\delta} .$ sin. $(\varphi' - \varphi)$. Now if we

substitute for r' and sin. $(\phi' - \phi)$ their values in terms of ϕ, or $\pi - \sigma$ deduced from the equations already stated, by proper eliminations, we find

$$P = \frac{2a}{\delta} \cdot \sqrt{1 - \cos.\ \lambda^2 .\ \cos.\ (\pi - \sigma)^2} \qquad (3)$$

whence the maximum effect of parallax on the angle of position of any double star is readily computed; the expression is inconvenient for logarithmic computation, but this inconvenience is obviated by the very obvious substitution

$$\cos.\ \lambda .\ \cos.\ (\pi - \sigma) = \cos.\ M;\ P = \frac{2a}{\delta} .\ \sin.\ M. \qquad (4$$

We also have

$$2a = \delta . \frac{P}{\sin.\ M} = \delta . \frac{\sin.\ P}{\sin.\ M} \qquad (5)$$

from which we may deduce the value of $2a$ the maximum of parallax when the total effect (P) on the angle of position is known.

If we take $P = 30'$ we have $2a = \delta . \frac{\sin.\ 30'}{\sin.\ M}$ (6)

which expresses the amount of annual parallax in any proposed star which will be indicated by a periodical variation of $30'$ in the angle of position. The smallness of this amount is a criterion (mathematically speaking) of the favourable or unfavourable nature of the individual star for researches of this kind.

By these theorems the proper times of year for observation, and the amount of difference of parallax, appreciable by a variation of $30'$ in the angle of position, have been computed for such stars among those observed by Mr. South and myself, in the paper above alluded to, as appear favourable to the application of the common wire micrometer to this enquiry, in the method now proposed. As the number of known double stars increases, others may easily be added to the list. The Catalogue of 460 double Stars observed by

Mr. SOUTH, and lately communicated to the Royal Society, will furnish a great many; and Mr. STRUVE's immense collection, amassed in his reviews with the large refractor, as well as a collection of minute double stars encountered in my own 20-feet sweeps, and which will shortly be published, doubtless many more; so that it is rather intended to give the following list as a specimen of a more complete one, than as including all, or nearly all, the stars it is desirable to examine with this view. Meanwhile, to enable others not conversant with algebraic symbols to extend the list for themselves, if so inclined, I shall here set down the whole work of calculation for one star.

Calculation for 35 Piscium. R. A. $0^h\ 6^m = \alpha = 1^\circ\ 30'$, Decl. $7^\circ\ 49'$ N. Long. $= l = 4^\circ\ 24'$. Lat. $= \lambda = +\ 6^\circ\ 32'$; Angle of position $= \pi = 298^\circ\ 4'$; Distance $= \delta = 12''.5$.

sin. obliq^y.	+ 9·60012	(2) tan. $(\pi-\sigma)$	−11·09285	(1) cos. lat.	+ 9·99717
cos. R. A.	+ 9·99985	sin. long.	+ 8·88490	(2) cos. $(\pi-\sigma)$	+ 8·90574
		(add)	−19·97775	(3) (add) cos. M	+ 8·90291
(1) ar. comp. cos. lat.	+ 0·00283	(1) 2 × log. sin. lat.	+ 8·11214	log. δ	+ 1·04798
				tan. 30′	+ 7·94086
sin. σ	+ 9·60280	(subtr.) tan. $(\odot - l)$	−11·86561		
σ	23° 27′	$\odot - l$	270° 47′	(add)	+ 8·98884
π	298 4	l	4 24	(3) sin. M	+ 9·99861
$\pi-\sigma$	274 37	$\odot$	275 11	(subtr.) log. 2 a	+ 8·90023
		$\odot + 6^s$	95 11	2 a	0·098
		Dates by Nautical Almanack .	Dec. 27 / June 27		

If we wish to avoid the computation of the latitudes and longitudes which this supposes known, they may be taken with sufficient precision from any good map, or from a large celestial globe, as exactness is not required for this purpose in these elements.

Specimen of a List of Stars

favourably situated for the Investigation of Parallax by the Method proposed in this Paper.

General Number in Messrs. H. and S's. Observations.	Stars' Name, &c.	R. A. for 1820.	Declination for 1820.	Times of the year most proper for Observation.	Amount of annual Parallax indicated by a periodical variation of 30′ in the angle of pos.
		h. m.	° ′		
1	35 Piscium	0 6	7 49 N	June 27, December 27..	0″.098
20	γ Arietis	1 44	18 25 N	January 31, August 3 ..	.085
25	α Piscium	1 53	1 53 N	January 18, July 19	.047
38	32 Eridani.....	3 45	3 30 S	February 12, August 15	.071
39	ε Persei	3 46	39 29 N	February 19, August 23	.081
46	55 Eridani.....	4 35	9 9 S	March 6, September 8..	.103
47	ω Aurigæ.....	4 47	37 36 N	March 5, September 7..	.069
53	Rigel	5 6	8 25 S	February 25, August 29	.084
55	118 Tauri.....	5 18	25 0 N	March 10, September 13	.052
56	32 Orionis.....	5 21	5 48 N	March 7, September 9..	.013
59	33 Orionis.....	5 22	3 9 N	March 6, September 8..	.020
67	ζ Orionis	5 32	2 3 S	March 18, September 20	.025
366	41 Aurigæ.....	5 58	48 44 N	March 21, September 23	.077
69	8 Monocerotis ..	6 14	4 41 N	March 21, September 24	.136
76	38 Geminorum .	6 44	13 24 N	April 1, October 4.....	.049
80	δ Geminorum ..	7 9	22 18 N	April 5, October 9.....	.064
88	11 Cancri	7 58	28 0 N	April 16, October 19...	.041
93	ϕ^2 Cancri.....	8 16	27 31 N	April 19, October 23...	.051
94	18 Bode, Hydræ	8 26	7 15 N	April 26, October 29 ..	.096
96	144 of 145.....	8 39	71 27 N	April 20, October 23...	.076
98	57 Cancri	8 43	31 16 N	April 27, October 30...	.020
99	17 Hydræ	8 47	7 17 S	May 12, November 14 .	.053
102	Cancri 194	8 57	23 42 N	April 30, November 2..	.067
114	Leonis 145	10 11	7 22 N	May 23, November 24..	.060
128	90 Leonis	11 25	17 48 N	June 4, December 6....	.039
133	65 Ursæ.....	11 46	47 29 N	May 21, November 23..	.035
134	2 Comæ.....	11 55	22 28 N	May 17, November 18..	.038
147	118 of 145.....	12 25	75 46 N	June 4, December 6....	.053
152	Str. 422	12 40	4 48 N	June 30, December 30..	.089
155	Str. 424	12 44	16 0 N	May 29, November 30..	.072
161	54 Virginis	13 4	17 51 S	January 13, July 15....	.060
167	81 Virginis	13 28	6 57 S	January 14, July 15	.038
73	98 of 145.....	14 5	6 14 N	January 15, July 17....	.054

Specimen of a List of Stars—*continued.*

General Number in Messrs. H. and S's. Observations.	Star's Name, &c.	R. A. for 1820.	Declination for 1820.	Times of the year most proper for Observation.	Amount of Annual Parallax indicated by a periodical variation of 30′ in the angle of pos.
		h. m.	° ′		
176	STR. 456.....	14 13	6 56 S	January 23, July 26....	0″.061
177	STR. 457.....	14 14	9 16 N	January 14, July 16....	.064
188	39 Bootis.....	14 44	49 27 N	April 2, October 5.....	.040
193	44 Bootis.....	14 58	48 21 N	February 10, August 13	.020
194	STR. 474.....	14 59	9 55 N	February 2, August 4..	.042
201	η Coronæ B....	15 16	30 57 N	January 28, July 31....	.014
205	δ Serpentis?....	15 26	11 9 N	February 6, August 9..	.027
206	Libræ 178.....	15 30	8 11 S	February 11, August 14	.104
211	II. 85.....	15 47	1 39 S	February 7, August 10.	.085
212	III. 103.....	15 48	3 56 N	January 31, August 2..	.132
228	g 5 Ophiuchi..	16 15	23 1 S	February 25, August 29	.036
240	——	16 46	19 15 S	March 3, September 5..	.064
245	39 Ophiuchi...	17 7	24 5 S	March 8, September 10.	.111
262	100 Herculis...	18 1	26 5 N	March 22, September 24	.125
265	I. 86.....	18 12	25 28 N	March 21, September 24	.040
269	39 Draconis...	18 21	58 42 N	April 28, November 1..	.031
271	——	18 30	41 7 N	March 22, September 25	.053
274	——	18 36	10 39 S	March 28, October 1...	.049
280	——	18 42	10 47 N	April 5, October 8.....	.042
287	——	18 58	6 53 N	April 2, October 5.....	.077
295	III. 57.....	19 19	20 46 N	April 7, October 10....	.062
306	π Aquilæ.....	19 41	11 22 N	April 8, October 11....	.021
311	ε Draconis.....	19 49	69 48 N	April 20, October 23...	.023
312	ψ Cygni.....	19 51	51 38 N	January 8, July 9.....	.038
313	I. 96.....	19 56	35 32 N	May 19, November 20..	.022
317	II. 96.....	20 3	0 19 N	April 30, November 2..	.045
320	I. 95.....	20 14	54 48 N	January 13, July 15....	.035
323	ς Capricorni II..	20 20	18 24 S	April 22, October 26..	.036
326	——	20 32	38 5 N	May 26, November 27.	.085
343	STR. 751.....	22 16	65 50 N	March 2, September 4..	.033
349	Aquarii 213....	22 34	9 11 S	May 28, November 28.	.031
352	——	22 59	31 51 N	February 24, August 28	.076
354	94 Aquarii	23 10	14 26 S	May 20, November 21..	.133
356	107 Aquarii ...	23 37	19 41 N	June 3, December 5....	.045
359	σ Cassiop.....	23 50	54 45 N	January 11, July 13....	.026

If I am not mistaken, then, we have here a method of investigating parallax very much more delicate than any which has yet been proposed—open to no insuperable objections—demanding no laborious reductions—and depending on a branch of practical astronomy, which is now happily cultivated with the assiduity it so richly deserves. It may not then be too much to hope, that in a few years we shall have data for a positive decision, respecting at least a certain number of individual stars, and thus be enabled to form a much better judgement as to the probable maximum of parallax in any. Meanwhile, the number of stars to which the method is applicable must not be judged of from the specimen above given. The only position micrometer of which I have any knowledge from practice is the wire micrometer; but the double image micrometer, if used in a manner, for the knowledge of which I am indebted to Captain KATER, and which consists in bringing the 1st image of one star almost, but not quite in contact with the 2nd image of the other, and in the same straight line, presents the singular advantage of an attainable exactness proportional to the distance of the stars; and by employing angles of position thus measured, stars of the 4th, 5th and 6th classes are rendered equally, or more available than those of the 1st, 2nd and 3rd; so that our range of objects becomes, by the use of this instrument in this manner really unlimited.

It is possible, that by some an apology may be thought necessary for a communication like the present—offered as it is to the Royal Society as a mere proposal—not followed out into actual practice. A variety of other pursuits, however, and circumstances less under my own controul, have

hitherto prevented, and will in all probability continue to prevent, my engaging actively in the very extensive and laborious series of observations required for this purpose. Should I do so in future, to which however I by no means intend to pledge myself, my progress must of necessity be extremely slow. But should the method itself appear really to possess the advantages I am inclined to ascribe to it, practical astronomers I am sure will hardly impute its publication, even unaccompanied with observations, as a fault; and if their energy and perseverance should anticipate me in its application, I hope I should be the first to acknowledge that the merit of the discovery of parallax must rest with him, who, whatever be the method he may pursue, shall first point out the star in which it exists, and establish it to the satisfaction of astronomers by unequivocal observations.

J. F. W. H.

London, Dec. 8, 1825.

XX. *A formula for expressing the decrement of human life. In a letter addressed to Sir* EDWARD HYDE EAST, *Bart. M. P. F. R. S. By* THOMAS YOUNG, *M. D. For. Sec. R. S. Communicated February* 2, 1826.

Read April 19, 1826.

MY DEAR SIR,

THE investigation of the laws, by which the general mortality of the human species appears to be governed, is of equal importance to the statesman, the physician, the natural philosopher, and the mathematician; and as you have had occasion to pay particular attention to the subject, I trust that it will not be disagreeable to you to receive the results of an inquiry, into which I have entered, for the purpose of appreciating, if not of reconciling, the many discordant opinions that have been advanced, respecting the comparative mortality of mankind, at different times, and under different circumstances.

Of late years, there is little doubt, that, whether from the protective effects of vaccination in infancy, or from the increase of the comforts of the poorer, and of the temperance of the more affluent classes of society, or in some measure also from the simplification of the practice of physic and surgery, there is a decided increase in the mean duration of life in many parts of Europe: but it is also extremely probable that this improvement has been greatly exaggerated; partly on account of the limited description of the persons on whom

the observations have been made, and partly from an erroneous opinion respecting the profits of certain establishments, which have been attributed to the employment of too low an estimate of mortality, while they have, in fact, been principally derived from the high rate of interest which the state of public credit has afforded.

A very laborious and well informed actuary has lately asserted, before a Committee of the House of Commons, that "the duration of existence now, compared with what it was a hundred years ago, is as four to three, in round numbers." (Parl. Rep. N. 522, p. 44.) It does indeed happen, that this particular result may in one sense be very correctly deduced from the immediate comparison of the annual mortality of a certain number of persons of the same description, that is, annuitants, at the periods in question; nor is it possible to deny that some importance must be attached to the remark: but the mortality of the same class of persons in France, at the earlier period, was no greater, according to Mr. DEPARCIEUX'S estimate of their longevity, than in England at the later, while the general mortality in France has never been materially less than in England, and appears at present to be even somewhat greater: and it can only be conjectured, that the annuitants of the tontine of King WILLIAM were in general most injudiciously selected, while those who were the subjects of Mr. DEPARCIEUX'S observations, like the annuitants of the modern tontines, were chosen with more care, or with greater success. Mr. FINLAISON'S tables, therefore, though they may be extremely just and valuable for the purpose of setting a price upon annuities to be granted on the lives of the proposers, cannot, with any prudence, be adopted where

the parties concerned have an interest in offering the worst lives that they can find ; notwithstanding any partial security that might be afforded by the exercise of medical skill in their rejection ; and if it is true, that some of the tontines were principally filled by lot (Rep. p. 16), with the children of country clergymen and magistrates, it must still be supposed that the families of such persons may have been more healthy than the average of the population of London and the country taken together.

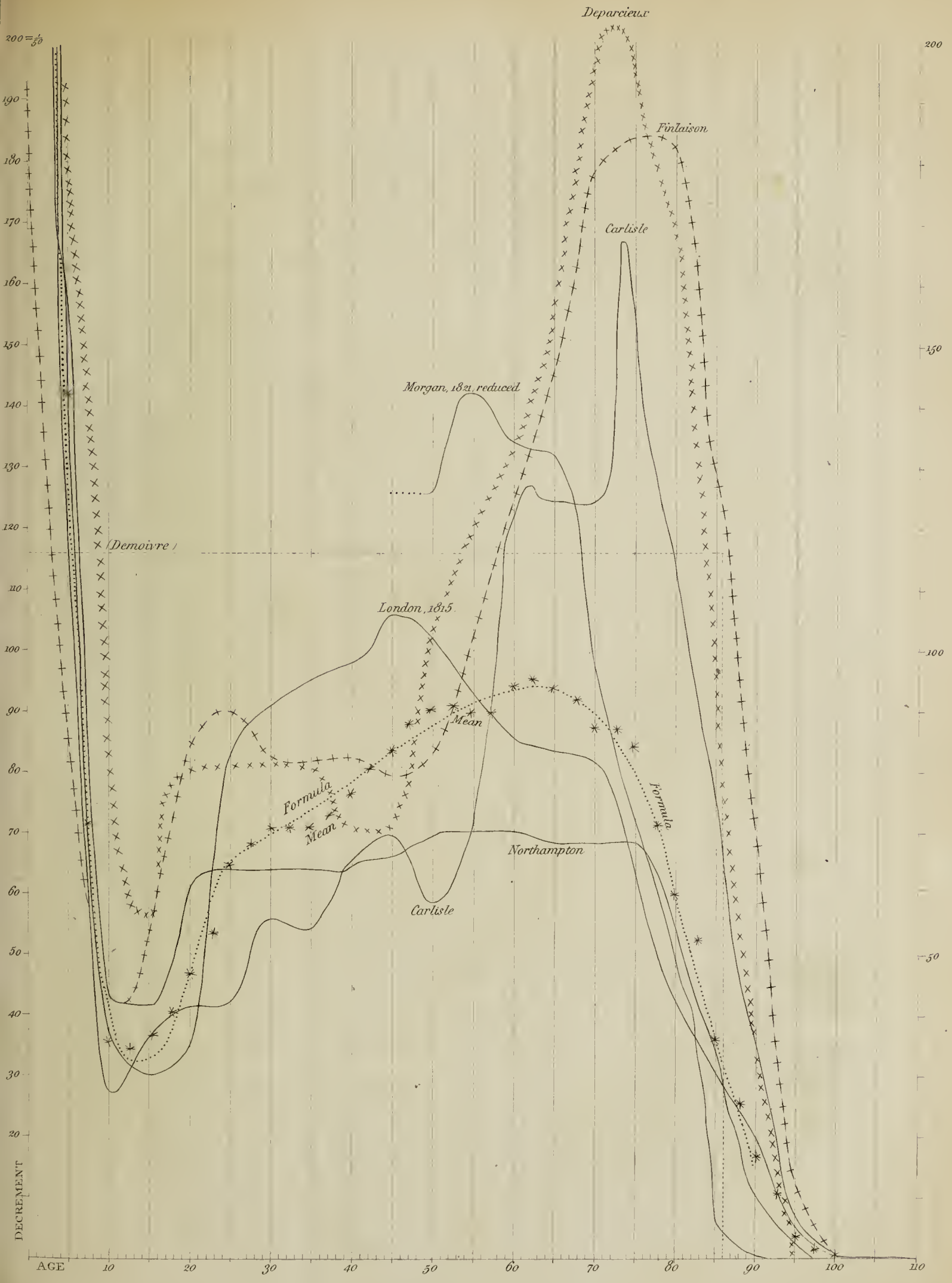
For the comparison of the general characters of different tables of mortality, the simplest and most obvious criterion is perhaps the number of individuals out of which one dies annually, which is also the number of years expressing the expectation of life at the time of birth. But this test is liable to material objections with regard to the most usual application of the table, which depends more on the comparative expectations at later periods than in early infancy. For example ; the Northampton table affords results, throughout the whole of middle and advanced life, agreeing almost exactly with DEMOIVRE's hypothesis of equal decrements, although the *annual mortality* is supposed to be nearly 1 in 25 at Northampton, instead of 1 in 43, as assumed by DEMOIVRE. It would therefore be very unjust for a person allowing the truth of DEMOIVRE's hypothesis, to condemn the practical employment of Dr. PRICE's tables in common cases, on account of this variation only. A less exceptionable test will be, to find the mean of the numbers expressing, for different ages, the *full term* of life, or the sum of the age and twice the expectation, taking the decads from 10 to 80 as the most important. Another standard of comparison may be the age

which is equal to the expectation of life, and which, in DEMOIVRE'S arithmetical hypothesis, is the *mean age* of all the population, and probably very near it in all tables formed from actual observation. In this manner a general comparison of the most remarkable tables may be instituted.

Characteristics of Mortality.

	Annual mortality one in	Mean full term of life.	Mean age.
Roman estimate of Ulpian, probably with some deduction for present value.....	.....	74 (+ disc^{t})	26 (+ disc^{t})
Deparcieux's Tontines, beginning 1689	47.67	94.17	32.5
Halley's table for Breslau, 1690.....	33.50	87.15	28.1
Tontine of 1695, Finlaison, males.....	37.61	83.42	27.25
——————— females	(43.0)	87.50	29.32
Simpson's table for London, about 1730	19.2	82.30	25.7
Dupré, in Buffon, about 1750	33.0	85.30	28.67
Northampton tables, about 1760.....	25.18	87.39	28.86
Swedish tables, about 1785.....	36.12	91.86	31.3
France, before the Revolution, Duvillard	28.76	86.96	29.0
Finlaison's tontine and annuitants, about 1800, males.....	50.16	93.25	32.0
females	55.51	100.7	34.6
Finlaison's Chelsea Pensioners	.....	90.0	29.65
Carlisle tables, about 1810, Milne.....	37.14	95.47	32.6
Returns for all England, 1811.....	49		

The order of the mortalities expressed by the first column of this table, is, SIMPSON, Northampton, France, DUPRE', HALLEY, Sweden, Carlisle, tontine 1695 males, females, DEPARCIEUX, returns of 1811, tontines of 1800, males, and females; the order of the second column is SIMPSON, tontine of 1695, males, DUPRE', France, HALLEY, Northampton, females 1695, pensioners, Sweden, tontines of 1800, males, Carlisle, females of 1800: but besides this difference in the order, the disproportion exhibited in this column is less enormous than in the former; the numbers of the Carlisle


Deparcieux
Finlaison
Carlisle
Morgan, 1821, reduced
Demoivre
London, 1815
Mean
Formula
Mean
Formula
Northampton
Carlisle
200 = 1/50
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
200
150
100
50
DECREMENT
AGE
10
20
30
40
50
60
70
80
90
100
110

F. Basire sc.

tables, for example, exceeding those of the Northampton by one half in the former, and by one tenth only in the latter. The proportion of Mr. FINLAISON's tontines also stands as 3 to 4 in the first, and as 7 to 8, or 8 to 9 only in the second: the latter comparison giving a much fairer practical estimate of the comparative longevity, indicated by the tables, than the former.

Another mode of easily appreciating the regularity and the analogies of different tables is, to construct a diagram, in the form of a curve, of which the absciss represents the age, and the ordinates the corresponding decrements of life. (Plate XI.) The inspection of such a diagram is sufficient to convince us of the great irregularity of the Carlisle tables of mortality, which must obviously have been formed, as they confessedly were, from observations on a very limited number of individuals, so that they exhibit a succession of different climacterics, after which the mortality is diminished, while about the age of 74 the curve that represents them towers to an incredible height, affording an expectation of longevity which some of the strongest advocates of those tables have abandoned in their practical applications, since they take their estimate of life, in advanced age, even lower than it is represented in the Northampton tables.

It appears therefore to be highly probable, that the fairest basis for general computations, to be applied throughout Great Britain, may be obtained by a proper combination of the tables of Northampton, which have been long known and very generally approved, with the Carlisle tables, corrected however in their extravagant values of old lives, by some other documents; and with the mortality of London as

derived from the parish registers, which, when thus incorporated with tables formed in the country, will be freed from the objections that have been made to the observations of burials in great cities only.

The Carlisle table agrees in the earlier parts pretty nearly with the observations of Mr. MORGAN on the experience of the Equitable Office from 1768 to 1810, as it appears from Mr. MILNE's comparison, as well as from the reduction and interpolation of those observations published by Mr. GOMPERTZ in the Philosophical Transactions for 1825: but for correcting the later portions of the Carlisle table, it may be allowable to employ a subsequent register of the experience of the Equitable Office, so far as it is possible to make any inferences from it with safety.

The numbers of deaths occurring in 20 years, as recorded by Mr. MORGAN, might have been made the foundation of a very valuable determination of the mortality occurring in a certain class of persons, if the number of the Equitable Society had become stationary before the commencement of the record: but in order to deduce from it a just estimate of the value of life, it would then be necessary to alter the numbers of deaths at each age, in the inverse proportion of the numbers of the living compared: that is to say, not simply of the sums of the persons admitted under that age, but of the numbers of persons born whom they represent: since, in comparing the joint mortalities of any two lists of persons, we must obviously add together the deaths belonging, not to a given number of persons of various ages, but of a number proportionate to the survivors at the respective ages out of a given number of births, so that in this manner the apparent mortality in the

earlier portions of the register would require to be augmented, not only on account of the smaller number of persons who have actually contributed to furnish it, but also on account of the greater proportion that these persons bear to the corresponding number at birth, when compared with the survivors at more advanced ages, who represent a population still more exceeding their own numbers. On the other hand, since the register in question relates only to a limited number of years, immediately following a very rapid increase of the Society, it is evident that the deaths must have occurred at earlier ages than if it had been continued until all the lives had dropped.

Of these three modifications, it may be sufficiently accurate for the present purpose to omit the two latter as nearly counterbalancing each other, and to augment the earlier numbers in the proportion only of the members of the Society to whom they must necessarily have belonged, supposing that the admissions had taken place about the same ages at all periods; assuming also the number of survivors at 45 to be in the same proportion to the births as in the Carlisle table. We may then proceed to take a mean between the mortality thus obtained, with proper interpolations, and the observations at Carlisle, as the second of the three principal bases to be afterwards incorporated with the mortality of Northampton and of London. Further than this, it is impossible to place any great reliance on Mr. MORGAN's document, which makes the annual deaths, in "a population exceeding 150000," not quite 1 in 1500.

Of the mortality of London, taken for the ten years from 1811 to 1820, it may be observed, that its results bear the

internal evidence of greater apparent correctness than either of the other bases, exhibiting a curve less irregular in its flexures, and generally intermediate between the others: it has also the advantage of exhibiting the duration of life as prolonged by the general introduction of vaccination: and when thus incorporated with the registers of two places in the country, each reduced to an equal supposed population, it must probably be sufficiently corrected for the errors that may be attributed to the effect of an afflux of settlers at an early age. The mean obtained in this manner might be employed at once as a standard table without much inconvenience, but it still exhibits some minute but obvious irregularities, as an inspection of the line of stars in the diagram will show, principally perhaps from the want of skill or care with which the interpolations have been made by Dr. PRICE and others. The most effectual of all interpolations for *harmonizing* the various orders of differences, is to obtain a formula which shall extend with sufficient accuracy throughout the whole curve. It may be easily believed that it must be extremely difficult to find such an expression; and that its form must be too complicated to be applied to any practical purpose throughout its extent. I have however drawn a curve which comes extremely near to the line of stars, and crosses it in 10 or 12 different points, by means of the equation $y = 368 + 10x - 11.(156 + 20x - xx)^{\frac{3}{2}} + \frac{1}{285 + 2.05xx + 2\left(\frac{x}{10}\right)^6} - 5.5\left(\frac{x}{50}\right)^{10} + \frac{5.5^2}{4000}\left(\frac{x}{50}\right)^{20} - 5500\left(\frac{x}{100}\right)^{40}$: y being the number of deaths among 100000 persons, in the year that completes the age x.

The terms of this formula have some remarkable relations to the different periods of life. HALLEY's first approximation was $y = 1000$, throughout life. DEMOIVRE's arithmetical hypothesis was $y = \frac{100000}{86} = 1163$: but of the present formula the principal foundation, as extending to the whole of life, is, $y = 368 + 10x$. In infancy the term containing the reciprocal of the powers of x has a preponderating value: in youth, the term $-(156 + 20x - xx)^{\frac{3}{2}}$, which diminishes the mortality, ends somewhat abruptly at 25, and would be incapable of being employed with safety in algebraical calculations, from its having a negative as well as a positive value. Old age is expressed almost exclusively by the high powers at the end of the formula, which terminate the series with great and increasing rapidity. It is obvious that for many purposes of calculation, the terms belonging to youth and to old age might be neglected without inconvenience, and that, for the middle portion of life, the terms $368 + 10x$ alone, with some little modification, might be employed as sufficiently correct; or certainly as much nearer to the truth than either the arithmetical or geometrical hypothesis of DEMOIVRE. The relations of the different parts of the formula will be best appreciated from their developement in the following tables.

DOCUMENTS.

Deaths among persons assured by the Equitable Society, for 20 *years, from* 1800 *to* 1821.—Morgan on Assurances, 1821, p. 325.

Age.	Deaths.	Assured.	Deaths cor.	Interpolations.			
10 to 20	7	1494		251	514	631	630
20 to 30	37	8996		275	566	636	630
30 to 40	166	33850		299	606	646	630
40 to 50	299	45429	630	323	616	655	630
50 to 60	458	36489	649	347	618	663	630
60 to 70	536	19042	604	371	620	665	
70 to 80	345 }	6454	{ 359	395	622	663	
above 80	82 }		{ 82	419	624	657	
				440	626	644	
		151754		470	628	630	(820)
				3590	6040	6490	20090
						Carlisle	45070

Mortality of London from 1811 *to* 1820.—Gent. Mag.

	Between 0 & 2	2 & 5	5 & 10	10 & 20	20 & 30	30 & 40	40 & 50	50 & 60	60 & 70	70 & 80	80 & 90	90 & 100	100	101	102	103	104	105	108	109	111	1
1811	5106	1638	654	509	1231	1641	1741	1591	1385	1038	449	56	1	1	1	1						
1812	5636	1907	655	620	1226	1685	1841	1543	1425	1193	492	71	0	0	1							
1813	5167	1733	604	526	1108	1501	1751	1606	1559	1211	489	61	1	1	1	0	0	0	0	2	0	
1814	5845	2038	770	649	1268	1678	1950	1810	1747	1343	592	88	1	1	1	0	0	0	1	0	1	
1815	5200	1916	870	677	1425	1824	2075	1886	1621	1221	674	167	2	1	0	1						
1816	5400	1960	845	675	1464	1912	2123	1955	1720	1308	781	168	3	0	0	1	1					
1817	5698	2019	929	706	1364	1795	1983	1788	1614	1224	683	156	7	0	0	0	0	2				
1818	5381	1815	808	703	1453	1884	2040	1864	1585	1271	722	175	1	1	1	0	0	0	1			
1819	4779	1771	826	631	1577	1990	2095	1918	1600	1230	666	144	0	0	0	1						
1820	4758	1975	887	667	1484	2006	2069	1878	1632	1208	662	119										
	52970	18772	7848	6363	13600	17916	19668	17839	15888	12247	6210	1205	16	5	5	4	1	2	2	2	1	
													(39)									19056

Interpolations.

Age.	Deaths.	Age.	Deaths.	Age.	Deaths.	Age.	Deaths.	Age.	Deaths.	Age.	Deaths.
0	32970	20	710	40	1855	60	1622	80	529	100	16
1	20000	21	770	41	1885	61	1615	81	768	101	5
	——52970	22	960	42	1925	62	1607	82	718	102	5
2	8500	23	1160	43	1963	63	1600	83	678	103	4
3	6000	24	1460	44	1990	64	1592	84	638	104	2
4	4272	25	1680	45	2010	65	1585	85	597	105	2
	——18772	26	1700	46	2020	66	1577	86	556	106	1
5	2800	27	1710	47	2020	67	1570	87	516	107	1
6	1800	28	1720	48	2010	68	1563	88	475	108	1
7	1400	29	1730	49	1990	69	1557	89	435	109	1
8	1008		——13600		——19668		——15888		——6210		——38
9	840	30	1741	50	1959	70	1550	90	380	110	1
	—— 7848	31	1752	51	1920	71	1478	91	290	111	0
10	740	32	1763	52	1880	72	1405	92	180	112	0
11	660	33	1774	53	1840	73	1333	93	90	113	0
12	615	34	1786	54	1800	74	1261	94	70		——1
13	605	35	1798	55	1760	75	1188	95	57		
14	600	36	1809	56	1720	76	1116	96	48		
15	603	37	1820	57	1680	77	1044	97	40		
16	610	38	1831	58	1650	78	972	98	30		
17	620	39	1842	59	1630	79	900	99	20		
18	640		——17916		——17839		——12247		——1205		
19	670										
	—— 6363										

Comparative Decrements from various Tables.

Age.	North-ampton.	Carlisle.	Equitable Office Red.	Mean of Carlisle and Eq. Office.	London Bills.	General Mean.	Living.
0	25751	15390			17301	19481	99124
1	11734	6820			10493	9682	79643
2	4309	5050	——	——	4460	4606	69961
3	2876	2760			3148	2928	65355
4	1691	2010			2242	1981	62327
5	1579	1210			1469	1419	60346
6	1202	820			945	989	58927
7	944	580	——	——	725	750	57938
8	687	430			529	549	57188
9	515	330			441	429	56549
10	446	290			389	375	56120
11	429	310			346	362	55745
12	429	320	——	——	323	357	55383
13	429	330			318	359	55026
14	429	350			315	365	54667

Comparative Decrements from various Tables.

Age.	North-ampton.	Carlisle.	Equitable Office Red.	Mean of Carlisle and Equi. Office.	London Bills.	General Mean.	Living.
15	429	390			317	379	54302
16	455	420			320	398	53923
17	497	430	—	—	325	417	53525
18	541	430			335	435	53108
19	575	430			352	452	52673
20	618	430			372	473	52221
21	644	420			404	489	51748
22	644	420	—	—	503	522	51259
23	644	420			608	557	50737
24	644	420			766	610	50180
25	644	430			882	652	49570
26	644	430			892	655	48918
27	644	450	—	—	897	664	48263
28	644	500			902	682	47599
29	644	560			907	704	46917
30	644	570			913	709	46213
31	644	570			919	711	45504
32	644	560	—	—	925	710	44793
33	644	550			931	708	44083
34	644	550			937	710	43375
35	644	550			943	712	42665
36	644	560			950	718	41953
37	644	570	—	—	955	723	41235
38	644	580			961	728	40512
39	644	610			967	740	39784
40	652	660			974	762	39044
41	661	690			990	780	38282
42	669	710	—	—	1010	796	37502
43	669	710			1030	803	36706
44	669	710			1044	808	35903
45	669	700	1346	(765)	1055	830	35095
46	669	690	1346	(821)	1059	850	34265
47	669	670	1346	(873)	1059	867	33415
48	669	630	1346	(916)	1055	880	32548
49	678	610	1346	978	1044	900	31668
50	695	590	1346	968	1028	897	30768
51	704	620	1375	997	1007	903	29871
52	704	650	1404	1027	987	906	28968
53	704	680	1416	1048	966	906	28062
54	704	700	1421	1060	945	903	27156
55	704	730	1416	1073	924	900	26253
56	704	760	1399	.....	902	894	25353
57	704	820	1381	.....	881	895	24459
58	704	930	1359	.....	866	904	23564
59	704	1060	1348	.....	856	921	22660

Comparative Decrements from various Tables.

Age.	North-ampton.	Carlisle.	Equitable Office Red.	Mean of Carlisle and Equit. Office.	London Bills.	General Mean.	Living.
60	704	1220	1342	.....	851	945	21739
61	704	1260	1338	.....	848	950	20794
62	695	1270	1333	.....	844	948	19844
63	695	1250	1329	.....	840	941	18996
64	687	1250	1325	.....	836	936	18055
65	687	1240	1321	.....	832	936	17119
66	687	1230	1317	.....	828	929	16183
67	687	1230	1295	.....	824	925	15254
68	687	1230	1210	.....	819	909	14329
69	687	1240	1098	.....	817	889	13420
70	687	1240	1005	.....	813	874	12531
71	687	1340	940	.....	776	867	11657
72	687	1460	895	.....	738	868	10790
73	687	1560	844	.....	700	863	9922
74	687	1660	792	.....	661	858	9059
75	687	1600	742	.....	623	839	8201
76	661	1560	690	.....	585	790	7362
77	627	1460	639	.....	548	741	6572
78	584	1320	587	.....	510	683	5831
79	548	1280	536	.....	472	643	5148
80	541	1160	480	.....	435	599	4505
81	515	1120	440	.....	402	549	3906
82	489	1020	300	.....	376	508	3357
83	472	940	200	.....	356	466	2849
84	412	840	100	.....	335	406	2383
85	351	780	60	.....	313	361	1977
86	291	710	40	.....	292	319	1616
87	241	640	30	.....	271	284	1297
88	180	510	20	.....	251	234	1013
89	137	390	10	.....	230	190	779
90	103	370	8	.....	199	164	589
91	86	300	7	.....	152	130	425
92	69	210	7	.....	94	87	295
93	60	140	6	.....	47	60	208
94	43	100	6	.....	37	44	148
95	26	70	5	.....	30	31	104
96	9	50	5	.....	25	19	73
97	0	40	5	.....	21	14	54
98	..	30	4	.....	16	9	40
99	..	20	4	.....	10	6	31

Comparative Decrements from various Tables.

Age.	North-ampton.	Carlisle.	Equitable Office Red.	Mean of Carlisle and Eq. Office.	London Bills.	General Mean.	Living.
100	..	20	4	.....	8	6	25
101	..	20	3	.....	3	5	19
102	..	20	3	.....	3	5	14
103	..	20	2	.....	2	4	9
104	..	10	2	.....	[1]	2	5
105	..	0	1	.....	1	1	3
106	..	..	0	.....	.5	(.25	(2.00
107	..	..	....	.....	.5	.25	1.75
108	..	..	....	.....	.5	.25	1.50
109	..	..	....	.....	.5	.25	1.25
110	..	..	....	.....	.5	.25	1.00
111	..	..	....	.....	...	.25	.75
112	..	..	....	.....	...	.25)	.50.
113	..	..	....	.....	...	.25)	.25)
114	..	..	....	.....	...	.0	.00)

Decrements of Mortality computed from the Formula.

Age $(x-1)$	$368 + 10x$	$-.11\,(156+20x-xx)^{\frac{3}{2}}$	$+\frac{1}{2.85+2.05xx+2\left(\frac{x}{10}\right)^6}$	Decrement.
0	378	−255	+ 20408	20531
1	388	241	9009	9106
2	398	313	4695	4780
3	408	359	2805	2854
4	418	386	1848	1880
5	428	409	1322	1341
6	438	427	968	979
7	448	440	746	752
8	458	447	592	603
9	468	451	477	494
10	478	447	392	423
11	488	440	329	377
12	498	427	278	349
13	508	409	238	337
14	518	386	205	337

Decrements of Mortality computed from the Formula.

Age $(x-1)$	$368 + 10x$	$-.11(156+20x-xx)^{\frac{3}{2}}$	$+\frac{1}{2.85+2.05xx+2\left(\frac{x}{10}\right)^6}$	$-5.5\left(\frac{x}{50}\right)^{10}$	Decrement.
15	528	359	178	.....	347
16	538	313	156	.....	381
17	548	291	136	.....	393
18	558	255	119	.....	422
19	568	214	104	.....	458
20	578	174	93	.....	497
21	588	130	82	.....	540
22	598	89	72	.....	581
23	608	51	64	.....	621
24	618	19	57	.....	656
25	628	0	50	.....	678
26	638	.....	44	.....	682
27	648	.....	39	.....	687
28	658	.....	34	.....	692
29	668	.....	30	.....	698
30	678	.....	27	.....	705
31	688	.....	24	.....	712
32	698	.....	21	.....	719
33	708	.....	18	.....	726
34	718	.....	16	.....	734
35	728	.....	14	.....	742
36	738	.....	13	.....	751
37	748	.....	11	—0	759
38	758	.....	10	.4	768
39	768	.....	9	.6	776
40	778	.....	8	.7	785
41	788	.....	8	.9	795
42	798	.....	7	1.2	804
43	808	.....	6	1.5	813
44	818	.....	5	1.9	821
45	828	.....	5	2.3	831
46	838	.....	4	3.0	839
47	848	.....	4	3.9	848
48	858	.....	3	4.5	857
49	868	.....	3	5.5	866
50	878	.....	3	6.7	874
51	888	.....	2	8	882
52	898	.....	2	10	890
53	908	.....	2	12	898
54	918	.....	2	14	906

Decrements of Mortality computed from the Formula.

Age $(x-1)$	$368 + 10x$	$-*+\frac{1}{2.85+2.05xx+2\left(\frac{x}{10}\right)^6}$	$-5.5\left(\frac{x}{50}\right)^{10}$	$+.001\left(\frac{5.5\left(\frac{x}{50}\right)^{10}}{2}\right)^2$	$-5500\left(\frac{x}{100}\right)^{40} =$	Decrement.
55	928	2	17	....	....	913
56	938	1	20	....	....	917
57	948	1	24	....	....	923
58	958	1	28	....	....	929
59	968	1	33	....	....	934
60	978	1	39	+ 0	....	938
61	988	1	46	1	....	942
62	998	1	55	1	....	943
63	1008	1	64	1	....	944
64	1018	1	75	1	....	943
65	1028	.....	—88	2	....	942
66	1038	.....	102	3	....	939
67	1048	.....	119	4	....	933
68	1058	.....	137	5	....	926
69	1068	.....	159	6	....	915
70	1078	.....	183	8	....	903
71	1088	.....	211	11	....	888
72	1098	.....	242	15	....	871
73	1108	.....	277	19	....	850
74	1118	.....	317	25	....	826
75	1128	.....	359	32	....	801
76	1138	.....	412	42	....	768
77	1148	.....	470	55	....	733
78	1158	.....	532	71	— 0	697
79	1168	.....	604	91	1	654
80	1178	.....	684	117	1	610
81	1188	.....	772	145	2	559
82	1198	.....	872	190	3	513
83	1208	.....	984	242	6	460
84	1218	.....	1108	307	9	408
85	1228	.....	1243	386	14	357
86	1238	.....	1399	490	22	307
87	1248	.....	1567	614	37	258
88	1258	.....	1756	771	52	215
89	1268	.....	1963	963	86	178
90	1278	.....	2192	1201	139	148
91	1288	.....	2444	1493	212	125
92	1298	.....	2713	1849	333	101
93	1308	.....	3032	2300	496	80
94	1318	.....	3371	2840	734	53
95	1328	.....	3744	3504	1041	27
(96	1338	.....	4150	4306	1746	0
97	1348					
98	1358					
99	1368					
100)	1378					

MEAN STANDARD TABLE OF THE DECREMENTS OF LIFE IN GREAT BRITAIN, 1824.

Age.	Decrement.	Living.	Age.	Decrement.	Living.	Age.	Decrement.	Living.	Age.	Decrement.	Living.
0	20531	100003	30	705	46527	60	938	21810	90	164	589
1	9106	79472	31	712	45822	61	942	20872	91	130	425
2	4780	70366	32	719	45110	62	943	19930	92	87	295
3	2854	65586	33	726	44391	63	944	18987	93	60	208
4	1880	62732	34	734	43665	64	943	18043	94	44	148
5	1341	60852	35	742	42931	65	942	17100	95	31	104
6	979	59511	36	751	42189	66	939	16158	96	19	73
7	752	58532	37	759	41438	67	933	15219	97	14	54
8	603	57780	38	768	40679	68	926	14286	98	9	40
9	494	57177	39	776	39911	69	915	13360	99	6	31
10	423	56683	40	785	39135	70	903	12445	100	6	25
11	377	56260	41	795	38350	71	888	11542	101	5	19
12	349	55883	42	804	37555	72	871	10654	102	5	14
13	337	55534	43	813	36751	73	850	9783	103	4	9
14	337	55197	44	821	35938	74	826	8933	104	2	5
15	347	54860	45	831	35117	75	801	8107	105	1	3
16	381	54513	46	839	34286	76	768	7306	106	.25	2
17	393	54132	47	848	33447	77	733	6538	107	.25	1.75
18	422	53739	48	857	32599	78	697	5805	108	.25	1.50
19	458	53317	49	866	31742	79	654	5108	109	.25	1.25
20	497	52859	50	874	30876	80	610	4454	110	.25	1.0
21	540	52362	51	882	30002	81	559	3844	111	.25	.75
22	581	51822	52	890	29120	82	513	3285	112	.25	.50
23	621	51241	53	898	28230	83	460	2772	113	,25	.25
24	656	50620	54	906	27332	84	408	2312	114	0	0
25	678	49964	55	913	26426	85	357	1904			
26	682	49286	56	917	25513	86	307	1547			
27	687	48604	57	923	24596	87	258	1240			
28	692	47917	58	929	23673	88	215	982			
29	698	47225	59	934	22744	89	178	767			

I shall take this opportunity of endeavouring to demonstrate, in a simple and undeniable manner, the error into which Dr. PRICE and his followers have fallen, in consequence, as it appears, of their adopting the legal restraints on usury as essential steps in the mathematical calculation of the amount of compound interest. The error has indeed of late

years been very commonly admitted; but its effects have not been so satisfactorily rectified as could be desired.

In the 66th volume of the Philosophical Transactions, for the year 1776, we find a Paper of Dr. PRICE, in which he lays down these theorems, r denoting the interest of £1. for a year, and n the term or number of years during which any annuity will be paid, p the perpetuity, or $\frac{1}{r}$, y the value of an annuity paid yearly, and h half yearly: then, I, $y = p - \frac{1}{r(1+r)^n}$; and, II, $h = p - \frac{1}{r\left(1+\frac{r}{2}\right)^{2n}}$: and as examples, taking $r = .04$, and $n = 5$, we have $y = 4.4518$, and $p = 4.4913$.

Now, if we analyse the results thus obtained, by dividing them into the present values of the separate payments, they will stand thus:

I. Present value of £1. payable at the end of 1 year.	£.	.961538
2 years		.924556
3 years		.888996
4 years		.854804
5 years		.821927
		4.451821
II. Present value of 10 shillings, payable at the end of half a year	£.	.49020
1 year		.48058
$1\frac{1}{2}$		.47127
2		.46192
$2\frac{1}{2}$		.45286
3		.44398
$3\frac{1}{2}$		.43528
4		.42674
$4\frac{1}{2}$		.41837
5		.41018
		4.49138

The present values of 10 shillings are therefore assumed;

	I,	II,
at 1 year	.48077	.48058
2 years	.46228	.46192
3 years	.44450	.44398
4 years	.42740	.42674
5 years	.41096	.41018

The latter column exhibiting obviously a larger deduction for discount than the former; so that the rate of interest in the two calculations is by no means the same: although in the case of $r = .05$, they would respectively represent the highest rate of interest allowed by our laws to be received without a new investment or engagement: but this arbitrary restraint ought certainly not to affect the mathematical consideration of the question.

The difficulty, if any person thinks it such, may be avoided by a mode of investigation which I have lately had occasion to point out. "An annuity, of which a payment is due on a given day, is more valuable than an annuity purchased on that day, and to commence a year after, by the amount of a year's payment: and *the value of a life annuity, becoming payable at any intermediate time between the day of purchase and its first anniversary, will be greater than the simple tabular value of the annuity by a sum proportional to the anticipation of the payment*;" the increase of the value being very nearly uniform, when we suppose the anticipation to be gradually increased: this increase of the value comprehending obviously the greater probability as well as the greater proximity of each payment, and proceeding from day to day by very nearly equal increments. Thus, if we wished to purchase an

annuity of £100. a year, and its value were £1000., upon the ordinary supposition of the payments commencing after the end of a year; supposing that we desired to have the first payment made at the end of nine months, and the subsequent payments at annual intervals as usual, we should have to add £25. to the purchase money, making it £1025. at whatever rate of interest the value might have been computed. If we began at six months, £50., and if at three months, £75. must be added to the purchase: it being obvious that an additional £100. would be equivalent to an anticipation of twelve months, or to an immediate payment of a year's annuity.

From this simple and incontestable principle, in which the second differences only are neglected, it is very easy to deduce the values of annuities, payable at intervals shorter than a year. An annuity of 1, payable half yearly, is equal to two annuities of $\frac{1}{2}$, the one beginning as usual at the end of the year, the other anticipated by half a year; and the value of this portion is greater than the other by half of one of the payments, that is, by $\frac{1}{4}$: so that "*We may always find the value of a life annuity payable half yearly, by adding a quarter of a year to the tabular value of the same annuity.*"

In a similar manner it is very easily shown, that "*for quarterly payments, we must add $\frac{3}{8}$ of a year's value to the computation made on the supposition of annual payments;*" and "the continual bisection of the interval would at last afford us *the addition of half a yearly payment for the value of a daily or hourly payment of a proportional part of the given annuity.*"

"It may also be observed, that when we reckon at 3 per

cent. interest, an annuity payable half yearly is the same, throughout the middle of life, that would be granted on the life of a person a year older, if payable annually."

If it is required to ascertain the value of a reversionary annuity payable half yearly or quarterly, the calculation becomes in appearance a little paradoxical; for since the true value of a reversionary annuity for the life of one person, for example, after the death of another, is the difference between the values of two annuities on the single life and the joint lives, and since an equal addition must be made to these values in consideration of the period of payment being shortened, it follows that the reversionary annuity must be of equal value in either form. This conclusion would indeed be strictly true if the periodical times of payment remained unaltered, according to the supposition from which the value of the annuities is deduced; while in fact it is usual to grant such an annuity to commence at the first quarterly, half yearly, or annual period after the contingent event: a variation which would have no sensible effect in the case of daily payments, but which lessens the value of reversionary annuities at other periods by that of half a payment for the given period, reduced to the present time in the same manner as any other sum assured as payable upon the same contingency of survivorship.

The simplicity observable in the progression of the values of annuities, calculated according to the values of lives here supposed, and at 3 per cent. interest, leads us to inquire what would be the exact law of mortality required to make that progression strictly uniform throughout life; and it will appear on investigation, that in order to have the value $24.45 - \frac{1}{4}x$,

x being the age of the person, which is nearly true between 20 and 70, the annual mortality must be expressed by $\frac{.03x + .066}{100.8 - x}$: a fraction which at 20 becomes $\frac{1}{121}$, at 40, $\frac{1}{48}$, at 60, $\frac{1}{22}$, and at 80, $\frac{1}{8.4}$. Our table gives respectively $\frac{1}{103}$, $\frac{1}{50}$; $\frac{1}{23}$, and $\frac{1}{7.3}$: the Northampton $\frac{1}{71}$, $\frac{1}{48}$, $\frac{1}{25}$, and $\frac{1}{7.4}$. Mr. FINLAISON'S male annuitants $\frac{1}{87}$, $\frac{1}{73}$, $\frac{1}{32}$, and $\frac{1}{8.3}$. The healthiness of Mr. FINLAISON'S annuitants about 40 and 50 is one of the most remarkable features of his table: he observes (p. 58), that out of 10,000 persons at 23, 141 will die in a year, and 141 will die out of the same number at the age of 48; but at the age of 34 there will only die 124. The curve marked by obelisks, +, in the diagram, will show the comparative progress of mortality in this system; which, however valuable the data may be, appears to exhibit too many novelties, if not anomalies, to be generally adopted with confidence: while the line of crosses, ×, representing the tontine of DEPARCIEUX, will serve to show how little difference the lapse of a century has made in the results of these two similar cases.

I shall conclude, my dear Sir, with a comparison of the climacteric years, as they may be called without impropriety, in which the greatest numbers of adults die, as taken from different tables.

I sincerely hope that these considerations may help to undeceive the too credulous public, who have of late not only received some hints that tend to insinuate the probability of an occasional recurrence of a patriarchal longevity, but who have been required to believe, upon the authority of a most respectable mathematician, that the true and unerring value

of life is not to be obtained by taking an average of various decrements, but by adopting the extreme of all conceivable estimates, founded only on a hasty assertion of Mr. MORGAN, and unsupported by any detailed report; an estimate which makes the grand climacteric of mankind in this country, not a paltry fifty four, or the too much dreaded sixty three; but no less than EIGHTY TWO! An age to which nearly one sixth of the survivors at ten are supposed to attain!

Climacterics, or greatest Decrements.

Berlin, formerly.... 38	Breslau, 1695 61	Montpellier, 1782...67	Deparcieux 73
London, about 1733.40	Formula 63	Duvillard, France...67	Carlisle 74
Paris, formerly.....40	Brandenburg.....65	Sweden, 1762.....68	Ackworth, 1752....75
Stockholm, 1762....42	Warrington, 1777 .. 65	Chester, 1776 68	Kersseboom.....77
London, 1764 43	Norwich, 1765..... 66	Sweden, 1785 69	Finlaison.....78
London, 1815 46		Holycross, 1760 70	E. O. Mr. B.....82
Northampton, 1757. 56			

Believe me, dear Sir,

Your faithful and obedient Servant,

THOMAS YOUNG.

Park Square, 28 Feb. 1826.

XXI. *Account of an experiment on the elasticity of ice. By* BENJAMIN BEVAN, *Esq. In a Letter to Dr.* THOMAS YOUNG, *For. Sec. R.S.*

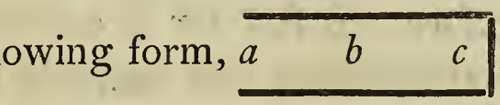
Read April 27, 1826.

DEAR SIR, Norwich, January 18, 1826.

I HAVE been long desirous of repeating my experiment on the elasticity of ice, but until the present frost have not had an opportunity for two years, when I had but a single specimen, and rather too small, and which broke soon after the commencement of the experiment. From that experiment I had calculated a modulus of 6.000,000 feet; but finding the result of my experiments in the present season much less, and pretty uniform amongst themselves, I re-examined the calculations made in 1824, and have discovered an error, which had before escaped me, in the reduction, and which brings the result of that experiment to agree with those made in the present season, or about 2.100,000 feet. I will not answer for the absolute correctness of the second figure, because a variation of the $\frac{1}{100}$ of an inch in the thickness of the specimen will change this figure.

The present severe frost has enabled me to try experiments on a much larger scale, and upon ice from $1\frac{1}{4}$ to 4 inches in thickness: to explain the mode I adopted with ice of near 4 inches in thickness may be necessary, and was as follows:

Upon a large pond within less than a mile of my residence at Leighton Bussard, the depth of which I found to be about

4 feet, I had a channel sawed on three sides of a parallelogram, in the following form, 

, separating the specimen to be operated upon, except at the end lettered *a*, where its union was left undisturbed. The dimensions of this prism was 100 inches long, 10 inches wide, and thickness at $a = 3.62$, at $b = 4.00$, and at $c = 3.75$ inches. To save some trouble in the calculation, I considered the thickness uniformly 3.97 inches or the mean of the whole: although I am aware that it would not be strictly accurate; but as the experiment was upon a large scale, and with weights up to 25 lbs. and with deflections proportional to the weights applied, I considered the experiment a fair one. In this experiment the weights were placed at 98 inches from the line of union with the main body, and the deflection by 25 lbs. was 0.206 inches; from which I estimate the modulus to be 2.100,000 feet.

After this, I repeated the experiment on ice of various dimensions and of different thickness, and in all, the result agreed quite as near as the admeasurement of the thickness could be ascertained, as well when the deflection was tried upon the water, as when the ice was taken out and tried in the manner used with wood and metal.

Now the modulus of water as given in your valuable lectures, derived from CANTON'S experiment, is, if I recollect right, about 750,000 feet, calculated from a condensation of $\frac{1}{22000}$ by the pressure of one atmosphere. This condensation, I presume, was *cubical* or solid; whereas the condensation used in regard to the modulus of elasticity is *linear*. You are of course aware that a linear compression of $\frac{1}{66000}$ will

produce a cubical condensation of $\frac{1}{22000}$, as found by CANTON. Allowing, therefore, 33 feet for a column of water = the pressure of the atmosphere, and multiply this by 66000, we shall have 2.178,000 feet for the modulus of water, agreeing pretty nearly with the result of my experiments.

I should not have troubled you with this letter, but as the frost may yet continue for a few days, an opportunity may be found of verifying, or correcting, the result of my experiments.

I am, with the greatest respect,

Your's truly,

B. BEVAN.

Leighton Bussard.

Note by Dr. YOUNG.

It does not appear quite clear from reasoning, that the modulus ought to come out different in experiments on solids and on fluids: for though the linear compression in a fluid may be only $\frac{1}{3}$ as much as in a solid, yet the number of particles acting in any given section must be greater in the duplicate ratio of this compression, and ought apparently to make up the same resistance. And in a single experiment made hastily some years ago on the sound yielded by a piece of ice, the modulus did appear to be about 800,000 feet only: but the presumption of accuracy is the greater in this case the higher the modulus appears.

XXII. *Results of the application of Captain* KATER's *floating collimator to the astronomical circle at the observatory of Trinity College, Dublin, and remarks relative to those results. By the Rev.* J. BRINKLEY, *D.D. F.R.S P.R.I.A. Communicated by the Board of Longitude February* 2, 1826.

Read April 27, 1826.

THE results of the observations which I am about to state will, I think, be considered as affording a strong testimony of the importance of the floating collimator. As applied to my circle, it furnishes the means of ascertaining the index correction with as great precision as by reversion, and in several points of view is undoubtedly superior to that method.

The reversing principle of the Dublin circle serves very conveniently for a measure of the accuracy of the floating collimator, and appears to show satisfactorily, that in the application of this instrument to any circle, no error belonging to the instrument will be introduced into the results; or in other words, that the results obtained by the assistance of the collimator, will not be sensibly affected by errors introduced by the collimator itself.

In the series of observations which I send, will be found—

I. The mean zenith distances of a number of stars, which were deduced solely by the application of the index correction, as determined by the collimator. In this way the circle was used as a mural circle; and as the observations were made both with the face of the circle east, and with the face

west, the results may be considered the same as if they had been determined by two mural circles.

II. The inclinations of the line of collimation of the collimator, as determined on different days, are given. The permanency of this inclination from day to day is by no means necessary; but it taking place, appears to give additional value to the collimator; and the exactness with which it can be ascertained, puts beyond all question that the collimator is applicable to the most powerful instruments.

III. The index corrections of the circle, as determined on different days by the help of the collimator. The uniformity of these results is affected by the exactness of the adjustment of the vertical axis of the circle by the plumb-line; and possibly the line of collimation of the telescope of the circle, at least the index correction, may suffer occasional changes by a very small derangement in the parts of the instrument, so as to vibrate as it were about a mean state.

IV. The index corrections, as determined by reversing from several stars. These, as well as the index corrections determined by the collimator, are affected with the errors of division.

It may serve for illustrating the importance of the floating collimator, to consider that it furnishes the observer with a fixed star, which he can place in his horizon (in fact at any *given* altitude), unaffected by refraction, visible at *any instant*, and on which he can make his observations in a closed room. That this fictitious star can be observed with as great exactness as a fixed star of the first magnitude under the most favourable circumstances of daylight. I cannot but think, had such a discovery been announced, and the means of

doing it not imparted at the same time, astronomers would have received it as one of the most important discoveries of modern times in this science, and anxiously expected its details.

What I have adduced in these tables of observations, will, I hope, assist in enabling others to appreciate the value of this new astronomical power, which, unless I deceive myself, may be considered as even belonging to a future more advanced state of practical astronomy.

Explanation of, and remarks on Table I.

The index corrections used in obtaining these results were found by the collimator. The zenith distances of the intersection of the wires of the collimator were found in the north and south positions. Half the sum of these is the inclination of the line of collimation of the collimator, and half the difference is the index correction. A mean of the index corrections, as determined on several days, has been used. This is not exactly the method suggested by Captain KATER; but the mean results must, in effect, be the same as if the correction had been determined for each observation. In making many observations with a large instrument, it would not be convenient, or perhaps advisable, to make for every star observed two cotemporaneous observations with the collimator. In this manner, however, a greater consistency in the separate results might be expected; but, as far as I have examined, there is no very marked superiority. That a judgment may be had, in three instances marked S, the results are deduced in this way; and certainly the agreement between the zenith distances of each day appears somewhat greater, than

when the mean index correction is used; but still the final results are the same.

The zenith distances determined in the two positions of the circle differ by the effect of the errors of division of the circle. These affect both the observations of the star and of the collimator; and the quantity of error in the index correction arising from the errors of division, will always have a contrary effect in the east and west positions. This will account for the apparent diversity in some of the means of the zenith distances determined in the two positions. The greatest discordance is in the case of α Cygni. From thence it appears possible, that the error of a zenith distance determined by help of the collimator with the face of the circle in one position only may amount to $1\frac{1}{2}''$, arising from the errors of division in the Dublin circle. It is not probable that a greater error would be found to exist in any part of the circle; but the effect of errors of division in the index corrections, as determined by the collimator, necessarily disappears by taking the mean of the east and west results. Therefore the means of the two positions ought to exhibit the results the same as determined by the method of reversion. The comparison given in Table I. (notwithstanding some of the stars have been only observed a few times), proves in a most satisfactory manner the exactness to be obtained by the use of the collimator. Of the 20 stars, only two differ by $1''$ from the former determination, and these do not differ by more than $1\frac{1}{2}''$.

In Table I. *f. w.* signifies that the observations were made by the fine wire of the telescope, which is about $\frac{1}{3000}$ of an inch in diameter, and was kindly furnished me by Dr. WOLLASTON:

where these letters do not occur, the observations were made by a grosser wire.

The mean index corrections for this latter wire, as determined by the collimator, were as follow:

To Aug. 22 inclusive, .	Index correct. South of zenith	E	−56″,30
		W	+ 54,46
From Aug. 25 to 29, ...		E	− 57,44
		W	+ 55,92
From Aug. 29 to Oct. 7, face W, ...			+ 59,90
From Oct. 7 to Nov. 10, face E, ...			− 59,11
From Nov. 10 to Dec. 3, face W, ...			+ 58,62

By the fine wire:

From Oct. 15 to Nov. 10, face E, ...	− 15,10
From Nov. 10 to Dec. 3, face W, ...	+ 15,01

The interval between the wires is 1′ 13″,92; and therefore previously to Oct. 15, the index correction for the fine wire is found by subtracting the index correction for the thick wire from the interval 73″,92. From Oct. 15 the index correction for the fine wire was found directly.

Explanation of, and remarks on Table II.

This table gives the inclination of the line of collimation of the collimator to the horizon, as observed on different days. It is not necessary that the collimation of the collimator should remain permanent from day to day; but when it is found to do so, it stamps an additional value on the instrument. It is only necessary that derangement should not take place in carrying it from one box to the other. This might be feared, when we consider how small a change in the relative position of the parts of the instrument would dis-

turb the observation. A displacement of the intersection of the cross wires of the collimator of only $\frac{1}{14000}$ of an inch, might occasion an error of 1″ in the inclination; so that it appears really wonderful that the collimation of the collimator has not for weeks together suffered perceptible derangement. The deviations from the mean are only such as may be safely attributed to the errors of observation and slight effects of change of temperature, except perhaps in one instance, the 27th July.

The determination of the inclination is independent on the position of the axis of the circle, and therefore also furnishes a criterion of the degree of exactness to which observations with the collimator may be made.

Explanation of, and remarks on Table III.

The index corrections given in this Table are those, by help of which the mean index corrections used for Table I. have been determined. It will be seen, that while the circle was frequently reversed (often many times in the same day), the corrections appear more variable than when the instrument remained for a length of time without being reversed. This was to be expected. An inexact adjustment of the vertical axis of the circle affects the index correction; and this is much more likely to take place when the circle is frequently reversed, than when not reversed. Indeed, from the reversals made for the purpose of trying the collimator, a source of error arose that was pointed out in the first instance by the collimator, and in so doing it furnished a strong testimony for itself.

It will be remarked, that in July and August the index

corrections for the face east differ from those for the face west. This is the circumstance alluded to, and requires explanation.

After the circle is reversed, the plumb-line adjustment is made, if necessary; and then the index correction ought to be precisely the same in quantity as before reversal, provided the parts of the instrument or the plumb line have suffered no derangement in the reversion. I had formerly particularly attended to this circumstance, which I was enabled to do by means of 4 gold dots placed by the maker on the face of the circle. The plumb-line having been made to bisect the adjusting dot on the *frame* of the circle, a gold dot on the lower part of the circle was also bisected by the plumb-line by moving the circle. The circle was then reversed; and if when the dot on the frame was bisected by the plumb-line the dot on the circle was also bisected by the plumb-line, the circle had turned without derangement, at least the plumb-line had suffered no derangement as to its point of suspension. The examination of this is tedious and delicate; and having satisfied myself that no error was to be feared, it was not usually attended to. However, when the observations with the collimator were commenced, it was soon found that the index correction appeared greater on the east side than on the west; and therefore that probably, in the act of reversing, a small derangement about the point of suspension of the plumb-line took place, less than a second in its mean quantity. This was fully confirmed from the examination by the gold dots. The result of this would have been to have made the zenith distances south of the zenith, when computed from the east and west readings, appear greater than they ought; whereas, not regarding the plumb-line as to reversal, and

using the collimator, the true results are obtained. This accounts for the inequality of the index corrections in the two positions of the circle.

By precautions since taken, the circle now appears to turn without being subject to this inconvenience. It is only an inconvenience, because the quantity of correction is obtained by the gold dots; but not so conveniently or so satisfactorily as by the collimator. Latterly however the reversals have been but rare, as I considered it desirable to continue the circle for some time together in the same position, that the collimator might be tried under various circumstances. The steadiness of the line of collimation of the circle, and of the line of collimation of the collimator in the periods in which the circle remained in the same position, is remarkable.

Explanation and remarks on Table IV.

This Table shows the index error obtained by observing the same star in the east and west positions of the face of the circle. It is given to show the general agreement with the same determined by the collimator, taking a mean between the results by the collimator on the east and west sides. But this is not the accurate quantity to be applied to each observation, as will be understood by what was stated in the explanation of Table III. This fourth table also serves to show that there is great uniformity between the adjacent quadrants of the Dublin circle.

Additional remarks on Table I.

Some of the discordances of the east and west results may appear greater than would have been expected; but it is to

be considered that each is a single observation, not the mean of two; and with reference to the collimator, the errors of division have necessarily, and may also with respect to the star, have contrary effects. Add to these the sources of error arising from inexact bisection of the plumb-line dot, from the bisection of the star from reading off; and, in so large an instrument as the Dublin circle, from the effects of unequal temperature, to which may be also added the irregularities of refraction; and then we may rather wonder greater discordances are not sometimes to be found. The deviation from the mean very rarely indeed mounts to $3''$; and it is to be remembered, that a second in the circle is only about $\frac{1}{4000}$ of an inch. It may be objected, that with reference to mural circles, in which the reversing principle cannot be applied, the effect of the errors of division on the index correction cannot be done away. In mural circles the principal means of obtaining the index correction are observations of the pole star above and below the pole, and by observing by reflection. The difficulties that occur in the practice of these two methods, when contrasted with the use of the collimator, are surely not compensated by the advantage of obtaining perhaps the index correction more free from the errors of division. When we consider Mr. TROUGHTON'S improved method of dividing, and the application of six microscopes to a mural circle, we need not fear any appreciable error in determining by the floating collimator the index correction. Besides, as Captain KATER has pointed out, we may by changing the inclination of the collimators bring into use different parts of the circle, and so avoid the effect of errors of division.

By a comparison of the inclinations of the line of collimation of the collimator, as determined in October and November by both the fine wire and thick wire, it will be seen that, as far as errors of observation are concerned, an error of a second rarely takes place. It may therefore serve to illustrate the powerful optical principle, on which the application of the collimator is founded, to remark that, as the collimator furnished by the Board of Longitude is only about 13 inches long, a space of less than $\frac{1}{20000}$ of an inch is ascertained; for to such a degree of exactness the position of the cross wires of the collimator can be ascertained. Thus perhaps a most severe test of a micrometer screw might be furnished.

J. BRINKLEY.

Table I.

Mean zenith distances reduced to Jan. 1st, 1825, found by applying the index correction, as determined by the collimator, to the observed zenith distances, and reducing them by the equations.

1825.	Face of Circle. East.	Face of Circle. West.
	α Cassiopeæ.	
Oct. 8	2 11 21,79	
9	21,67	
12	19,12	
14	22,35	
15	22,63	
21	20,99	
25	20,06	
Nov. 3	20,61	
7	23,32	
9	20,88	
11	.....	2 11 22,76
14	.....	21,56
16	.....	21,86
17	.....	22,93
24	.....	22,50
25	.....	22,24
Means	2 11 21,34	2 11 22,31
		21,34
	Mean	2 11 21,82
	By Catalogue	22,14
Using single observations of collimator made nearest to the time of observation of the star.		
Oct. 8	2 11 21,89	
9	21,77	
12	19,81	
S 14	21,54	
15	21,87	
21	21,48	
25	20,95	
Nov. 3	20,38	
7	23,31	
9	22,70	
11	.....	2 11 22,38
14	.....	21,48
16	.....	21,32
17	.....	22,39
24	.....	22,42
25	.....	22,16
Means	2 11 21,57	2 11 22,03
		21,57
	Mean	2 11 21,80

1825.	Face of Circle. East.	Face of Circle. West.
	Aldebaran.	
Aug. 5	37 14 15,80	37 14 15,21
6	14,48	14,81
7	14,67	13,86
Means	37 14 14,98	37 14 14,63
		14,98
	Mean	37 14 14,80
	By Catalogue	15,41
1825.	Capella.	
July 25	.....	7 34 38,52
29	.....	40,80
30	7 34 41,60	
Aug. 4	40,96	
5	.....	38,47
6	40,58	
7	.....	36,92
9	.....	37,63
Means	7 34 41,05	7 34 38,47
		41,05
	Mean	7 34 39,76
	By Catalogue	40,72
1825.	β Tauri.	
Aug. 5	.....	24 56 10,51
6	24 56 11,65	
7	.....	24 56 10,89
		24 56 10,70
		11,65
	Mean	24 56 11,17
	By Catalogue	12,76
1825.	α Orionis.	
July 25	.....	46 1 14,88
29	.....	14,66
30	46 1 14,76	
Aug. 5	12,11	13,81
7	13,64	12,98
8	13,84	
10	11,94	
Means	46 1 13,26	46 1 14,08
		13,26
	Mean	46 1 13,67
	By Catalogue	14,95

1825.	Face of Circle. East.	Face of Circle. West.
	Sirius.	
July 24	69 52 14,07	
25	.....	69 52 12,29
27	11,22	
Aug. 22	11,27	9,59
Sept. 3	.....	9,03
Means	69 52 12,19	69 52 10,30
		12,19
	Mean	69 52 11,24
	By Catalogue	10,87
1825.	Procyon.	
Aug. 5	47 43 13,01	
22	13,75	47 43 14,11
Sept. 3	f. w.....	14,52
	47 43 13,38	47 43 14,31
		13,38
	Mean	47 43 13,84
	By Catalogue	13,97
	Arcturus.	
July 28	33 17 20,57	
29	.....	33 17 20,62
Aug. 5	19,08	
Sept. 5	.....	21,84
14	f. w.....	20,83
21	f. w.....	20,92
29	f. w.....	22,55
Oct. 7	f. w.....	24,94
21	21,45	
Nov. 5	f. w. 18,79	
9	f. w. 21,59	
10	f. w.....	21,94
18	f. w.....	22,61
29	f. w.....	22,15
Dec. 2	f. w.....	22,77
3	.....	21,47
Means	33 17 20,30	33 17 22,06
		20,30
	Mean	33 17 21,18
	By Catalogue	21,03

Table I.—*continued.*

Mean zenith distances reduced to Jan. 1st, 1825, found by applying the index correction, as determined by the collimator, to the observed zenith distances, and reducing them by the equations.

	Face of Circle. East.	Face of Circle. West.
	α Cor. bor.	
1825.		
Aug. 22	26 4 39,31	26 4 40,24
23	36,09	39,75
29	f. w.....	40,73
31	f. w.....	39,73
Means	26 4 37,70	26 4 40,11
		37,70
	Mean	26 4 38,90
	By Catalogue	38,63
	α Serpentis.	
1825.		
Aug. 29	f. w.....	46 24 14,59
31	f. w.....	13,30
Sept. 5	f. w.....	14,70
	Mean	46 24 14,20
	By Catalogue	13,59
	α Herculis.	
		f. w.
Aug. 29	.....	38 47 22,74
30	.....	22,59
31	.....	23,28
Sept. 5	.....	24,28
6	.....	25,22
7	.....	22,66
8	.....	24,61
10	.....	25,01
22	.....	22,28
	Mean	38 47 23,63
	By Catalogue	23,15

1825.	Face of Circle. East.	Face of Circle. West.
	α Ophiuchi.	f. w.
	.....	40 41 30,16
Aug. 29	.....	30,07
30	.....	29,26
31	.....	29,62
Sept. 5	.....	31,43
6	.....	31,42
10	.....	30,30
14	.....	29,09
22	40 41 33,53	
Nov. 4	30,71	
9		
Means	40 41 32,12	40 41 30,17
		32,12
	Mean	40 41 31,14
	By Catalogue	30,17
	γ Draconis.	
1825.		
July 24	1 52 26,63	
25	23,74	
28	.....	1 52 22,89
29	.....	23,68
Aug. 2	.....	22,76
17	27,28	
18	.....	24,08
21	24,22	
29	.....	23,29
31	.....	24,05
Sept. 5	.....	23,59
10	.....	21,33
12	.....	23,75
14	.....	22,18
17	.....	22,36
22	.....	23,34
28	.....	25,48
Oct. 4	.....	24,69
21	f. w. 26,75	
Nov. 4	f. w. 26,95	
7	f. w. 26,73	
9	f. w. 26,22	
16	f. w.....	26,53
17	f. w.....	26,11
19	f. w.....	26,40
25	f. w.....	25,89
Dec. 2	f. w.....	26,80
Means	1 52 26,07	1 52 24,17
		26,07
	Mean	1 52 25,12
	By Catalogue	25,11

1825.	Face of Circle. East.	Face of Circle. West.
	α Lyræ.	
July 2	14 45 36,23	14 45 36,77
15	35,48	37,24
16	37,33	34,91
17	36,67	38,47
18	39,18	37,14
19	39,46	36,08
25	37,87	
27	.....	38,00
28	40,90	
29	.....	36,21
Aug. 2	.....	36,91
6	38,00	
10	37,40	39,17
17	40,50	38,59
18	38,02	37,66
21	40,71	37,38
22	37,67	39,83
24	39,00	39,20
25	39,18	39,40
29	.....	39,26
30	.....	38,08
31	.....	37,81
Sept. 5	.....	34,98
6	.....	37,55
8	.....	37,46
12	.....	37,29
14	.....	38,41
16	.....	37,30
22	.....	34,85
27	.....	41,06
28	.....	40,38
30	.....	39,28
Oct. 14	41,76	
17	40,09	
21	40,26	
Nov. 4	40,54	
7	40,46	
9	39,54	
11	.....	38,56
12	.....	39,55
16	.....	40,07
25	.....	40,53
Dec. 2	.....	40,66
3	.....	40,42
Means	14 45 38,92	14 45 38,18
		38,92
	Mean	14 48 38,55
	By Catalogue	38 32

Mean zenith distances reduced to Jan. 1st, 1825, found by applying the index correction, as determined by the collimator, to the observed zenith distances, and reducing them by the equations.

Table I.

	Face of Circle. East.	Face of Circle. West.
1825.	α Aquilæ.	
Oct. 7	44 58 24,03	
14	21,02	
15	24,78	
17	21,77	
19	23,13	
29	24,48	
Nov. 4	24,69	
7	24,52	
9	23,87	
10	25,02	
12	.....	44 58 24,83
15	.....	25,90
Dec. 2	.....	26,93
3	.....	25,62
Means	44 58 23,73	44 58 25,82
		23,73
Mean		44 58 24,77
By Catalogue		24,26
1825.	α Cygni.	
Aug. 10	8 43 38,64	8 43 39,12
29	.....	37,41
31	.....	34,92
Sept. 3	.....	39,12
4	.....	37,83
6	.....	36,89
10	.....	38,64
13	.....	37,49
22	.....	36,51
26	.....	37,69
29	.....	39,18
Oct. 15	41,78	
25	41,36	
29	41,21	
4	41,02	
7	40,85	
9	43,49	
10	42,27	
11	.....	38,19
12	.....	38,87
14	.....	38,19
16	.....	39,42
17	.....	39,16
Dec. 2	.....	40,44
3	.....	39,00
Means	8 43 41,33	8 43 38,23
		41,33
Mean		8 43 39,78
By Catalogue		40,26

	Face of Circle. East.	Face of Circle. West.
	Using single observation of collimator made nearest to the time of ob. of the star.	
Aug. 10	.....	8 43 38,26
29	.....	38,21
31	.....	35,03
Sept. 3	.....	37,84
4	.....	36,55
6	.....	37,71
10	.....	38,19
S 13	.....	39,12
22	.....	38,87
26	.....	38,32
29	.....	37,57
Oct. 15	8 43 42,54	
25	40,41	
29	42,23	
Nov. 4	41,25	
7	40,86	
9	41,67	
10	40,05	
11	.....	38,57
12	.....	38,87
14	.....	38,27
16	.....	39,96
17	.....	39,70
Dec. 2	.....	40,62
3	.....	38,28
Means	8 43 41,29	8 43 38,33
		41,29
Mean		8 43 39,81
By Catalogue		40,26
	2 α Capricorni.	
Aug. 29	.....	66 27 58,55
31	.....	57,41
Sept. 3	.....	54,04
4	.....	57,38
6	.....	56,92
10	.....	59,12
11	.....	60,51
13	.....	55,62
22	.....	59,70
26	.....	62,28
27	.....	60,18
28	.....	59,02
Oct. 4	.....	59,12

	Face of Circle. East.	Face of Circle. West.
1825.	2 α Capricorni—*continued.*	
Oct. 7	66 27 58,61	
14	58,06	
15	60,28	
17	58,04	
29	58,40	
Nov. 4	59,44	
7	59,20	
9	60,74	
10	59,37	
12	.....	60,65
Dec. 2	f. w.....,	63,57
Means	66 27 59,13	66 27 58,94
		59,13
Mean		66 27 59,03
By Catalogue		59,11
1825.	α Pegasi.	
Aug. 29	.....	39 7 14,89
Sept. 27	.....	17,35
28	.....	17,34
29	.....	16,55
30	.....	16,97
Oct. 7	39 7 17,47	
8	16,10	
12	19,10	
13	18,29	
14	16,10	
21	17,53	
25	17,07	
29	14,94	
Nov. 3	16,52	
4	15,84	
7	15,36	
9	18,10	
10	17,87	
11	.....	15,79
16	.....	16,50
Dec. 3	.....	13,83
Means	39 7 16,95	39 7 16,15
		16,95
Mean		39 7 16,55
By Catalogue		16,22

Mean zenith distances reduced to Jan. 1st, 1825, found by applying the index correction, as determined by the collimator, to the observed zenith distances, and reducing them by the equations.

Tab. I.	Face of Circle. East.	Face of Circle. West.
1825.	α Andromedæ.	
Oct. 8	25 15 45,78	
14	44,52	
21	46,22	
25	46,60	
Nov. 3	47,07	
4	46,70	
7	45,55	
9	46,71	
10	47,80	
11	.....	25 15 44,63
14	.....	45,14
16	.....	46,17
17	.....	45,05
24	.....	46,17
25	.....	46,04
Means	25 15 46,32	25 15 45,63
		46,32
Mean		25 15 45,92
By Catalogue		45,60

Using single observation of collimator made nearest to the time of observation of the star.

Oct. 8	25 15 45,65	
14	45,35	
21	46,43	
25	45,71	
Nov. 3	47,30	
4	46,93	
7	45,56	
S 9	44,89	
10	46,58	
11	.....	25 15 45,01
14	.....	45,22
16	.....	46,76
17	.....	45,59
24	.....	46,25
25	.....	46,12
Means	25 15 46,04	25 15 45,82
		46,04
Mean		25 15 45,93
By Catalogue		45,60

1825.	Face of Circle. East.	Face of Circle. West.
	Polaris.	
Oct. 7	34 59 17,44	
f. w.	18,51	
8	17,88	
f. w.	18,37	
15	18,98	
f. w.	18,85	
21	18,56	
f. w.	18,83	
Nov. 7	18,63	
f. w.	19,78	
9	17,87	
f. w.	18,60	
11	.....	34 59 19,69
f. w.	.....	16,92
14	.....	18,94
f. w.	.....	17,71
17	.....	18,80
f. w.	.....	17,53
Means	34 59 18,52	34 59 18,26
		18,52
Mean		34 59 18,39
By Catalogue		18,06

1825.	Polaris, S. P.	
Aug. 22	38 14 16,05	38 14 13,23
12	14,75	
f. w.	15,34	
20	15,09	
f. w.	16,19	
28	16,26	
f. w.	16,43	
Nov. 10	15,30	
f. w.	15,59	
10	.....	14,75
f. w.	.....	13,18
11	.....	14,46
f. w.	.....	13,75
18	.....	17,25
f. w.	.....	16,40
Means	38 14 15,67	38 14 14,72
		15,67
Mean		38 14 15,20
By Catalogue		14,94

Co. lat. by Polaris, 36 36 46,8.

	North pole dist. Jan. 1, 1825, by collimator.	N. P. dist. by Catalogue.	Diff.
	° ′ ″	″	
α Cassiopæ ..	34 25 24,68	24,36	+ 0,32
Aldebaran ..	73 51 1,30	1,91	— 0,61
Capella.....	44 11 26,26	27,22	— 0,96
β Tauri	61 32 57,67	59,26	— 1,59
α Orionis....	82 38 0,17	1,45	— 1,28
Sirius.....	106 28 57,74	57,37	+ 0,37
Procyon.....	84 20 0,34	0,47	— 0,13
Arcturus....	69 54 7,68	7,53	+ 0,15
α Cor. bor. ..	62 41 25,40	25,13	+ 0,27
α Serpentis...	83 1 0,70	0,09	+ 0,61
α Herculis ...	75 24 10,13	9,65	+ 0,48
α Ophiuchi...	77 18 17,64	16,67	+ 0,97
γ Draconis...	38 29 11,62	11,61	+ 0,01
α Lyræ.....	51 22 25,05	24,82	+ 0,23
α Aquilæ....	81 35 11,27	10,76	+ 0,51
α Cygni.....	45 20 26,28	26,76	— 0,48
2 α Capricorni	103 4 45,53	45,61	— 0,08
α Pegasi.....	75 44 3,05	2,72	+ 0,33
α Andromedæ	61 52 32,43	32,10	+ 0,33
Polaris.....	1 37 28,40	28,44	— 0,04
		Mean diff.	— 0,03

The above polar distances are deduced from the zenith distances by applying the co lat. 36 36 46,5; and the catalogue referred to is mine of 1823, given in the Phil. Trans. 1824.

J. BRINKLEY.

Table II.

	Inclination of Collimator.	
	Face East.	Face West.
	′ ″	′ ″
July 22	7 10,00	7 9,80
24	10,15	9,08
25	9,74	10,43
27	10,00	6,80
28	10,12	11,79
P. M.	10,22	9,48
30	8,89	11,80
31	9,06	9,60
Aug. 2	.....	10,71
3	11,37	12,47
4	11,47	
5	.....	9,52
6	10,31	
7	9,56	
8	.....	11,36
9	.....	11,36
P. M.	.....	10,89
10	8,61	
P. M.	10,85	
11	.....	11,40

Several days of excessive high wind shaking the walls of the room on which the collimator was supported.

Aug. 16	10,62	
17	10,22	
18	.....	10,30
19	.....	10,78
20	.....	11,01
21	11,00	
Means	7 10,13	7 10,47

Cleaned mercury, and at same time cleaned bottom of collimator, which may have caused a small change in the inclination.

Aug. 26	11,01	11,48
27	11,85	12,43
28	12,13	12,80
29	11,07	12,00
P. M.	12,16	

From this time the circle remained in the same position for a considerable interval.

	Inclination of Collimator.
	Face West.
	′ ″
Aug. 29	7 12,50
30	14,06
31	13,40
P. M.	14,28
Sept. 1	12,75
2	12,68
P. M.	13,60
3	11,94
4	11,38
5	9,45
6	12,45
7	12,18
8	12,10

Two days of storm.

10	12,88
11	12,35
14	12,03
21	12,93
22	10,99
27	8,83
28	10,49
Oct. 1	11,26
7	11,16
Mean	7 12,08

Reversed circle.

Circle turned without derangement of plumb-line, as ascertained by gold dot.

Face now East.

		Fine Wire.
Oct. 7	7 10,81	
13	11,07	
14	10,40	
15	10,62	10,40
17	11,67	11,33
21	9,93	10,00
22	8,60	9,12
24	10,48	10,21
27	10,57	10,98
28	11,43	11,92
29	11,58	11,50
Nov. 4	12,03	11,46
7	9,97	8,86
9	9,07	10,20
11	8,56	8,36
Means	7 10,45	10,36

Reversed circle.

	Inclination of Collimator. Face West.	
	Thick Wire.	Fine Wire.
	′ ″	″
Nov. 11	7 9,97	9,66
14	11,55	11,53
P. M.	9,53	10,52
17	10,06	10,77
19	10,16	10,72
25	10,93	10,90
30	11,91	12,11
Dec. 2	9,38	8,71
Cleaned mercury.		
3	12,03	12,05
Means	7 10,61	10,77

Table III.

	Index Correction.	
	Face East.	Face West.
1825.		
July 22	54,87	54,80
24	58,02	54,64
25	55,65	54,26
27	56,35	53,81
28	56,04	53,18
P.M.	59,28	55,72
30	55,31	52,98
31	59,16	52,90
*Aug. 2	.....	55,37
3	56,40	54,96
4	55,20	
5	.....	54,89
6	54,32	
7	53,93	
8	.....	54,95
9	.....	55,50
P.M.	.....	55,93
10	56,38	
P.M.	56,26	
11	.....	53,60
Several days of high wind.		
16	55,40	
17	58,02	
18	.....	55,20
19	.....	53,50
20	.....	54,08
21	56,50	
Means	—56,30	+54,46

Adjusted plumb-line dot, by which the index correction is necessarily affected. Cleaned mercury, &c.

Aug. 26	59,08	56,11
27	56,58	56,56
28	57,80	55,23
29	56,30	55,80
Means	—57,44	+55,92

* From this time the collimator was always lifted from the mercury, and replaced before the observation.

	Index correction.	
	Face East.	Face West.
Took off plumb-line, and cleaned notch.		
Aug. 29 P.M.	61,36	
Reversed circle, which remained with face west till Oct. 7.		
Aug. 29 P.M.	.....	60,70
30	.....	60,44
31	.....	60,77
P.M.	.....	60,01
Sept. 1	.....	60,25
2	.....	58,92
P.M.	.....	59,77
3	.....	59,97
4	.....	58,62
5	.....	58,98
6	.....	60,72
7	.....	59,08
8	.....	59,70
2 days of storm.		
10	.....	59,45
11	.....	60,18
14	.....	61,53
21	.....	59,91
22	.....	62,28
27	.....	60,53
28	.....	58,29
Oct. 1	.....	58,57
7	.....	59,03
Mean		+59,90

	Index correction.	
	Thick Wire.	Fine Wire.
Reversed Circle, face now East.		
Oct. 7	59,21	
13	59,80	
14	58,30	
15	58,35	15,63
17	57,84	15,70
21	58,90	14,67
22	59,60	14,65
24	58,58	15,28
27	60,90	15,15
28	58,76	15,85
29	58,09	16,08
Nov. 4	58,88	14,78
7	59,10	15,33
9	60,93	13,87
11	60,33	14,23
Means	—59,11	+15,10
Reversed Circle, face now West.		
Nov. 11	59,00	14,98
14	58,62	14,80
P. M.	58,70	14,86
17	59,16	14,70
19	58,86	14,75
25	58,70	14,67
30	57,88	15,61
Dec. 2	58,80	15,18
Cleaned Mercury.		
2	57,90	15,55
Means	+58,62	—15,01

Table IV.

Index corrections by reversion to Aug. 21 inclusive.		
α Lyræ	13 Ob. East, and 13 West	55″,80
γ Draconis	2 E 3 W	56,41
Arcturus	1 W 1 E.....	55,36
Aldebaran	3 W 3 E.....	55,55
β Tauri.....	2 W 1 E.....	55,85
α Orionis.....	4 W 3 E.....	55,20
Capellæ	5 W 3 E.....	56,67
α Cor. bor.....	2 W 2 E.....	55,53
Sirius.....	1 W 1 E.....	56,22
Procyon.....	1 W 1 E.....	55,20
α Cygni.....	1 W 1 E.....	55,10
Mean by Collimators E 56,30 W 54,46 } 55,38	Mean...	55,72

XXIII. *On the means of facilitating the observation of distant stations in geodætical operations. By Lieutenant* THOMAS DRUMMOND, *of the Royal Engineers. Communicated April 14, 1826, by Lieut. Colonel* H. COLBY, *F. R. S.*

Read May 4, 1826.

IN consequence of the Report of a Select Committee of the House of Commons in June 1824, it was resolved, that a new Survey of Ireland should be immediately undertaken.

The necessity of carrying on this extensive work with the utmost degree of rapidity, consistent with accuracy of execution, being strongly urged in the Report to which I have alluded, the arrangements were directed to be made on a suitable scale, and every method to be adopted that seemed likely to contribute to this end. The triangulation, as forming the basis of the survey, and the means of accelerating its execution, claimed immediate attention; and I was directed by Colonel COLBY, at that time actively engaged in making the necessary preparations for this important undertaking, to consider by what means our distant stations might be rendered more frequently observable than the state of the atmosphere usually permits.

From this source, at least in this country, arises the chief delay in carrying on such operations; and the experience of a previous season among the Western Islands, had shown the probability of this impediment being materially increased, and more than ordinary difficulty encountered, in effecting

the triangulation of Ireland, and in connecting that country with the western shores of Scotland and England. The connecting triangles are large, many of the sides being 60, 70, and 80 miles. The means resorted to for rendering these distant stations visible in ordinary states of the weather, and their successful application on some occasions of difficulty that presented themselves at the close of last year's operations, form the subject of the communication which I have now the honour of submitting to this Society.

The reflection of the sun from a plane mirror, as affording a point of observation that might be seen at remote distances, was suggested and employed by Professor GAUSS in 1822, while engaged with a trigonometrical measurement in Hanover; and the result of the first trials made at Inselberg and Hohenhagen, rendered it highly probable that it might be applied with much advantage to this purpose.

The principle was adopted in this country when Colonel COLBY and Captain KATER were engaged, in 1822, in verifying General ROY's triangulation connecting the meridians of Paris and Greenwich. At their concluding station on Shooter's Hill, seven or eight days had elapsed, during which Hanger Hill Tower, though only 10 miles distant, having remained completely obscured by the dense smoke of London, tin plates were attached to the signal post, so as to reflect the sun towards the station at stated times on a certain day.

At the hours for which they had been calculated these plates became visible, and the observations were in consequence immediately and easily completed. In the subsequent operations of 1823, recourse was again had on two important occasions to the same method, and with equal success. I

allude to Leith Hill, near Dorking, in Surrey, and Wrotham Hill, in Kent, stations which it was of the utmost consequence to observe from Berkhampstead Tower, near Hertford. Our efforts to effect these observations having for some time been rendered unavailing by the thick mist, so frequently overhanging the bed of the Thames, a series of bright tin plates was put up on both stations. Each set consisting of six or eight plates, was attached to a smooth flat board, placed vertically by the plumb line, and turning on a pivot: the respective inclinations of the plates with the face of the board being determined, so that they might have the positions required for reflecting, in succession, the sun's rays towards Berkhampstead tower, when the surface of the board was turned at right angles to the line of direction. Although this method admitted but of rude execution, it fully answered the purpose for which it was employed: the plates became visible in succession at the appointed hours, the duration of each varying with the inequality of its surface, but being generally from ten to fifteen minutes; they were seen nearly at the same hours for some days before and after that for which they were calculated.

The distance to Leith Hill is 45 miles, and the observations were in this way completed without the hill itself having been visible during the whole of our stay, which was nearly three weeks.

The utility of employing the sun's reflection as a point of observation being established by the result of these experiments, it only remained, instead of a temporary expedient, rather difficult of execution, to substitute an instrument that might be used on all occasions, simple

Fig. 1.

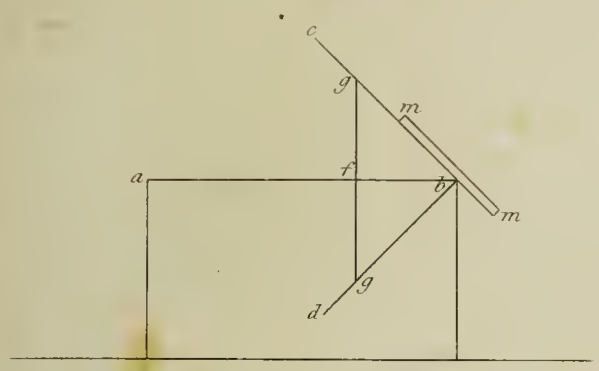
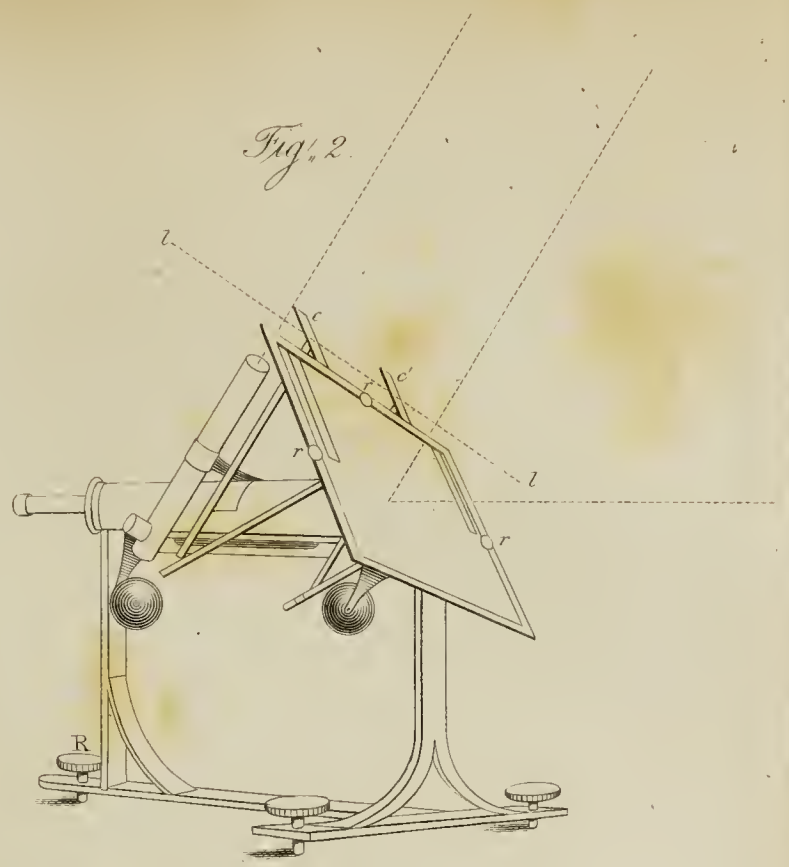
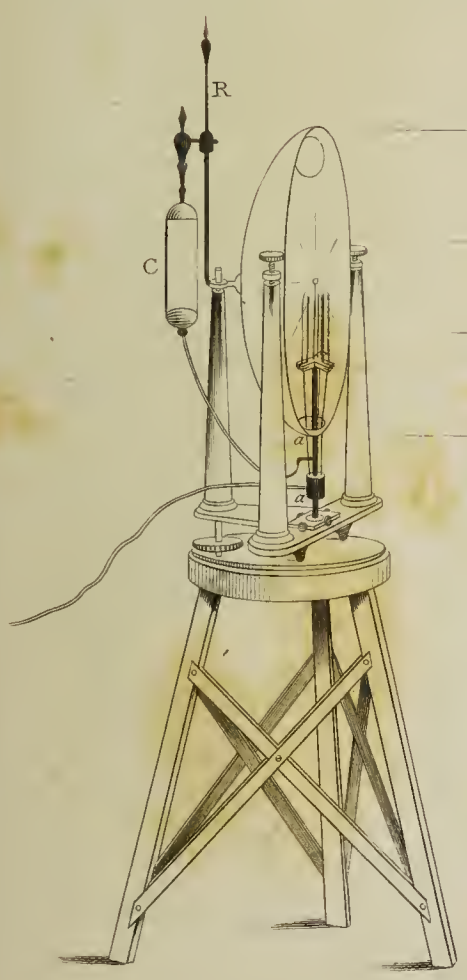


Fig. 2.



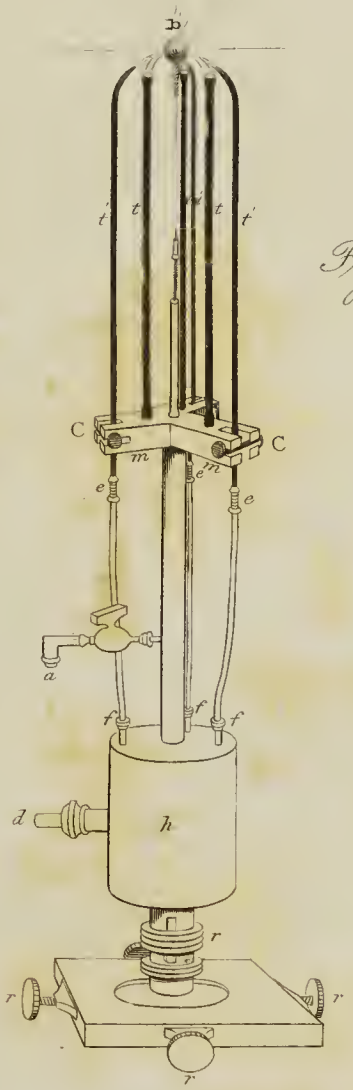
One Inch to One Foot.

Fig. 3.



One Inch to Eighteen Inches.

Fig. 4.



One Inch to Four Inches.

F. Basire sc.

in its construction, and easy of management. Fig. 1, Plate XII. represents an instrument contrived with this view, which was employed last year in Ireland with much advantage. *ab* is a telescope of 12 inches focal length, and serves as the axis of the instrument; the bars *bd* and *bc* form a right angle; and the bar *gg*, placed so that *bf* (fig. 2), shall be equal to *fg*, works between *bd* and *bc*, carrying a small telescope, such as is usually attached to sextants, and provided with a rectangular eye-piece. The mirror *mm*, of which different sizes may be used according to circumstances, is connected with the instrument by three adjusting screws *r*. The bars *bc*, *b'c'*, being now made to coincide with *ab*, a moveable spirit level is placed across them in the position *ll*, fig. 2, and rendered horizontal by the foot screws; by the same means the axis *ab*, to which a level is permanently attached, is also brought into a horizontal position. The moveable spirit level being now transferred to the surface of the mirror, the three adjusting screws *r*, are employed to render it horizontal. The mirror will then be parallel to *ab* and *ll*, and will have the required position on the instrument. The telescope *ab* being now directed upon the object to which the reflection is to be thrown, and the small telescope *gg* turned towards the sun, its rays will then be reflected parallel to the axis of the instrument *ab*. The head of the screw R, fig. 2, is graduated, so that by means of it and the spirit level attached to the axis, the required elevation or depression may be given to the instrument when the object towards which it is directed happens to be invisible, its direction only being known relatively to some nearer object; and which, it may be remarked, has been the case in every instance in which it

has been employed on the survey. When packed for travelling, the mirror *mm* is detached, and the bar *gg* turned till it coincides with *bf*. The instrument once directed, its management was usually confided to one of the non-commissioned officers.

To combine, with the heliostat now described, a means of exhibiting a bright light at night, that no opportunity might be lost of effecting our purpose, was the next consideration.

In the beginning of the survey, General ROY had, on several occasions, but especially in carrying his triangles across the Channel to the French coast, made use of Bengal and white lights prepared at the Royal Arsenal: for these, parabolic reflectors, similar to those with which our light-houses are supplied, and illuminated by argand burners, were afterwards substituted, as more convenient; but they have been gradually discontinued, the advantages derived from them proving inadequate, from their want of power, to the trouble and expense incident to their employment. In the trigonometrical operations of 1821 carried on by Colonel COLBY and Captain KATER, conjointly with MM. ARAGO and MATHIEU, for connecting the meridians of Greenwich and Paris, an apparatus of a very different kind was employed for the first time. A large plano-convex lens 0.76 metre square being substituted for a parabolic reflector, and the illuminating body an argand lamp with four concentric wicks. The lens was composed of a series of concentric rings, reduced in thickness and cemented together at the edges. This apparatus resulted from an inquiry into the state of the French light-houses, and was prepared under the direction of MM. FRESNEL and ARAGO. Its construction and advan-

tages are detailed in a " Mémoire sur un nouveau systême d'éclairage" by M. FRESNEL. The light which it gave is stated to possess $3\frac{1}{4}$ times the intensity of that given by a reflector. It was employed, during the operations alluded to, at Fairlight Down and Folkestone Hill on the English coast; at Cape Blancnez and Montlambert on the French coast: the greatest distance at which it was observed being 48 miles; and its appearance, I have understood from Colonel COLBY, was very brilliant.

But valuable as this apparatus may be when employed in a light-house, the purpose for which it was indeed invented and constructed, the properties of the simple parabolic reflector appeared still to give it a preference for the service of the Trigonometrical Survey, provided a more powerful light could be substituted in its focus, instead of the common argand lamp.

With this object in view, I at first endeavoured to make use of some of the most brilliant pyrotechnical preparations, then phosphorus burning in oxygen, with a contrivance to carry off the fumes of phosphoric acid was tried: but the first attempts with these substances promising but little success, they were abandoned. In all cases the flames, besides being difficult and troublesome to regulate, were large and unsteady; little adapted to the nature of a reflecting figure, which should obviously, when used to the utmost advantage, be lighted by a luminous sphere, the size being regulated by the spread required to be given to the light. This form of the focal light it was manifest, either could not be obtained or preserved when combustion was the source of light; and it was chiefly this consideration which then led me to attempt

applying, to the purpose in view, the brilliant light emanating from several of the earths when exposed to a high temperature; and at length I had the satisfaction of having an apparatus completed, by which a light so intense was produced, that when placed in the focus of a reflector the eye could with difficulty support its splendour, even at the distance of forty feet, the contour of the reflector being lost in the brilliancy of the radiation.

To obtain the requisite temperature, I had recourse to the known effect of a stream of oxygen directed through the flame of alcohol*, as a source of heat free from danger, easily procured and regulated, and of great intensity. Fig. 4 represents the apparatus such as it is now made for the survey. The spirit entering at *a*, ascends through the tubes *t*, while the oxygen entering at *d* is directed by the jets *t'* upon the small ball of lime *b*, the tubes *t'* are connected with the cylindrical box *h* by flexible caoutchouc tubes *ef*, and also pass with friction through small cylinders at *c*, which admit of being moved backwards and forwards upon the arms, and are clamped when in the proper position by small millheaded screws at the sides. By these means every requisite adjustment is obtained for the jets through which the gas issues. The apparatus is attached by its base to the stand which carries the reflector (fig. 3, Plate XII.) and the small ball may then, by means of the horizontal and vertical screws *r*, be brought with great accuracy into the focus of the reflector. The cistern *c* containing the alcohol is placed behind the reflector (fig. 3,) and being connected with the stem *a* by a flexible caoutchouc tube, may be elevated or depressed on

* Annals of Philosophy, vol. ii. p. 99.

the upright rod *r* fig. 3, and the flame of the spirit accordingly regulated so as to produce the greatest effect. A flexible tube leads from *d* to the vessel containing the oxygen, which may be either a common gas-holder, or perhaps a silk bag with a layer of caoutchouc, such as they are now made, might be conveniently employed for this purpose. The apparatus first made was provided with five jets, and could light up a ball $\frac{3}{8}$ inch in diameter; that now represented has only three, and with it a ball $\frac{1}{4}$ of an inch in diameter may be used sufficiently large to admit of the requisite allowance being made for aberration in the reflector from its true figure, as well as uncertainty of direction arising from terrestrial refraction.

To ascertain the relative intensities of the different incandescent substances that might be employed, they were referred, by the method of shadows, to an argand lamp as a common standard; the light from the brightest part of the flame being transmitted through apertures, equal in diameter to the small spheres of the different substances submitted to experiment.

The result of several trials made at the commencement gave for

Lime . . . . . 37 times
Zirconia* . . . 31 times
Magnesia . . . 16 times the intensity of an argand burner. The oxide of zinc was also tried; but besides wasting away rapidly, it proved inferior even to magnesia.

* From the description given by Berzelius of the light emitted by zirconia before the common blow-pipe, a different result might have been expected.

Of these substances, and also of their compounds with one another, lime appearing to possess a decided superiority, my subsequent experiments were confined to it alone, and by a more perfect adjustment of the apparatus, by bringing the maximum heat, which is confined within narrow limits, exactly to the surface of the ball, and by using smaller balls than those employed in the early experiments, a very material increase of light has been obtained. The mean of 10 experiments, made lately with every precaution, gives for the light emitted by lime, when exposed to this intense heat, 83 times the intensity of the brightest part of the flame of an argand burner of the best construction, and supplied with the finest oil. The lime from chalk, and such as is known at the London wharfs by the name of flame lime, appears to be more brilliant than any that has been tried.

When well burned Carrara marble is made into a paste with water, and gradually dried, it appears to be nearly equal to the preceding: when strongly compressed, or very porous, in both cases it is inferior.

The lime from the chalk, besides being the most brilliant, is in other respects very convenient for use; it admits of being turned in the lathe, and thus any number of the small focal balls, with slender stems attached to them, may be prepared with the utmost facility, uniform in size, and perfect in figure. The surface of the ball, by the continued action of the heat, appears to be kept nearly in a state of fusion; it is gradually worn down; and, on cooling, presents a semi-crystalline appearance. Being desirous of ascertaining what effect so intense a light would have on a mixture of chlorine and hydrogen, two tubes 10 inches long, with bulbs about

two inches in diameter blown at one extremity, were filled with a mixture of these gases, and placed within two inches of the luminous ball of lime, which was $\frac{3}{8}$ of an inch in diameter. The additional light, reflected by a concave mirror $9\frac{1}{2}$ inches in diameter, was also concentrated on one of the balls.

After some minutes exposure to the light the glass began to get dim, especially on the sides nearest the light, being covered with a thin whitish film; at the end of 15 minutes they were withdrawn, and the stop-cocks being opened, under water coloured with an infusion of litmus, it immediately rushed in, filling one-third of the ball on which the reflected light had also been concentrated, and one-half of the other exposed to the direct light only: the difference probably arising from some accidental inequality in the brightness of the opposite sides of the ball. The purple tint of the litmus was rapidly changed to red, which, again by the action of the uncombined portion of chlorine, gradually faded away, and was soon destroyed. The effect of the light on chloride of silver was equally remarkable. Three portions, one at the distance of about an inch from the luminous ball, the other four, and the third in the focus of the violet rays, concentrated by a powerful lens, were exposed to the influence of the light for twelve minutes, and were then found to be completely discoloured; that nearest the light being almost black, the other two having a brownish black hue. Having now described the instruments contrived to facilitate the observation of the distant stations of the survey, it may not perhaps be uninteresting to add an account of their successful application to a case of considerable importance and difficulty, that occurred at the end of last season.

Slieve Snaght, the highest hill of Innishowen, about 2100 feet above the sea, and 15 miles N. of Londonderry, forms an important point in the triangulation, which connects the North of Ireland with the western islands of Scotland.

On the 23d of August last a conspicuous object was placed on its summit, that it might be observed from the Divvis Hill, near Belfast, where we were then encamped. Having continued, however, till the 26th October, enveloped in a haze so impenetrable as to render unavailing every effort made for this purpose, Colonel COLBY resolved, although the season was far advanced and the weather unsettled, that an attempt should be made to surmount this formidable obstacle, by the aid of the instruments now described. By his directions I proceeded with a party of men to the hill in question, which we reached on the 27th October. For the first ten or twelve days after our arrival we had to struggle against most tempestuous weather, and being only provided with round tents, which resisted but for a short time the violence of the successive gales, it was with some difficulty and exertion that we maintained ourselves on the hill, and preserved the instruments themselves from destruction. At length, however, the weather becoming moderate, both instruments were brought into use, and we had the satisfaction of learning from Lieutenants HENDERSON and MURPHY, to whom Colonel COLBY had confided the task of completing the observations, and whose vigilance the first glimpse of the light did not escape, that on the 9th and 10th of November both instruments had been brilliantly visible, and the observations in consequence brought to a satisfactory conclusion. The distance between the stations is $66\frac{1}{4}$ miles; but the difficulty

experienced in observing Slieve Snaght appears to have arisen not so much from the distance, as from the direction passing over a range of other hills, and not far above their tops. Of twelve observations, made during the day, on the ninth and tenth of November, not more than one could have been effected without the aid of the heliostat, and many were obtained when the outline of the hill itself had ceased to be visible. The light at night was referred to a 15 inch parabolic reflector, illuminated by an argand lamp, and placed on the church tower of Randalstown, nearly in the same direction. The light on the distant hill was not only seen with the naked eye, but appeared much brighter and larger than that at Randalstown, their relative distances being nearly 67 and 15 miles. Colonel COLBY proposes employing this light to effect the observation of Ben Lomond from Knock Layd, in the north-east extremity of Ireland, a distance of not less than 95 miles; and availing himself of the position of Ben Lomond, which commands a view of the Observatory on the Calton Hill of Edinburgh, to determine by simultaneous observations, the difference of longitude between it and Knock Layd, which is nearly in the meridian of the Dublin Observatory.

It may perhaps be asked, if this mode of producing light does not admit of being applied to other purposes, besides those of a Trignometrical Survey: and, that, which naturally suggests itself, as a very extensive and important application, is the illumination of light-houses. Not being subject to explosion, it might be employed without incurring the slightest danger: and the apparatus, when fixed and permanent, might be rendered so simple, that the most ordinary care and attention

would be sufficient for its management. Even on the survey this requires no peculiar address, notwithstanding the inconveniences of very exposed situations, and the necessity of rendering every article as portable as possible. The expense may appear, at first sight, the strongest objection to its general use; but, supposing rectified spirits to be employed, with the duty remitted, and no further use to be made of the oxide of manganese, after the abstraction of the oxygen,* it may be stated, in general terms, that while the intensity of light varies between 60 and 90 times that of an argand lamp, the expense would not exceed ten times. Applied to a revolving light, where four sides are illuminated, each with four reflectors, one reflector, with the lime light, might be substituted on each side, and with an increased expense of $2\frac{1}{2}$ times that of the oil an intensity varying between 15 and 22 would be obtained. It will also be recollected that the oil consumed is far from constituting the most considerable portion of the expense of maintaining a light-house, and that it would probably not be underrated if estimated on an average at one-fourth. The other sources of expenditure would, in both cases, be the same. How far this increased expense would be an objection to its general introduction into light-houses, is for others to determine; but there are, I should apprehend, situations, such for example, as the Lizard Point, the Scilly Islands, or the great Skellig,† off the south-west extremity of Ireland, where the advantages of so powerful a light would

* It is not improbable that some simple process might be found for causing the manganese to absorb from the atmosphere the oxygen which it had lost by exposure to heat; in this case the expense would be diminished about two-thirds.

† A light-house is now building on this remarkable rock, which will be of great importance, being the first made by vessels from America.

not be considered too dearly purchased at such a price. Whether it would be most advantageous to collect the light with common parabolic reflectors, or to adopt the system of lenses and plane reflectors, proposed by M. FRESNEL, with such modifications as the peculiar nature of the light might admit or require, would readily be determined by experiment. There are good grounds for believing that this latter mode would be found the most economical and effective; and that a light-house might be brilliantly illuminated by a single ball of lime; in which case the expense would not exceed, if it equalled that of oil. It might not be uninteresting at the same time, to enquire what degree of light could be obtained from lime, by employing atmospheric air with common oil or tallow, as the source of heat. From some rough experiments made with this view, it seemed not improbable that it would possess considerable superiority over that of an argand lamp. But whatever might be the result of these enquiries, it will probably be admitted that enough has already been practically carried into effect, to show that no formidable difficulty stands in the way of the application of this mode of illumination to light-houses, and that the subject is not undeserving the attention of those, to whose charge these important establishments are committed.

XXIV. *On the production and formation of pearls.* By Sir Everard Home, *Bart. V. P. R. S.*

Read May 11, 1826.

For the last four years I have been engaged, with the aid of Mr. Bauer's microscopical observations, in examining the mode of generation of the fresh water muscle and oyster; illustrating the changes that occur by Mr. Bauer's drawings in the same manner as has been done with respect to the egg of the pullet, the frog, the earth worm and barnacle. But as it will require another season to complete this investigation, I am desirous of preceding it with an account of the formation of pearls; the discovery of which was made in the early parts of my enquiry into the mode of generation of the fresh water muscle.

I am the more desirous of laying before the Society these new facts respecting pearls at this moment, when the public mind is directed to the improvement of the pearl fishery, and therefore every thing respecting them will be received with greater interest than at any other time.

In examining the organs of generation of the large fresh water muscle, I very frequently met with what are called seed pearls; and these were always found in the ovarium, or connected with the shell on which the ovarium lay. I at the same time accidentally discovered that all oriental pearls that are split into two halves have a brilliant cell in the centre;

this, however, where the pearl has been bored is destroyed, and upon comparing the size of the central cell with that of one of the ova, it is exactly large enough to contain it. The ova themselves are formed upon pedicles, in the same manner as the yelks of the pullet's eggs; and must, when completely formed, have a similar mode of being discharged.

From these facts I have been led to conclude, that a pearl is formed upon the external surface of an ovum; which having been blighted, does not pass with the others into the oviduct, but remains attached to its pedicle in the ovarium, and in the following season receives a coat of nacre at the same time that the internal surface of the shell receives its annual supply.

This conclusion is verified by some pearls being spherical, others having a pyramidal form, from the pedicle having received a coat of nacre as well as the ovum.

The best mode of rendering the central cell conspicuous, is setting one half of a split pearl in a ring with the divided surface outwards, and looking at the cell through a magnifying glass.

Mr. BANKS, the optician, in the Strand, has succeeded in contriving an apparatus for this purpose, from which the annexed magnified drawing is taken.

It is the nacral shining lining of the central cell that produces the lustre peculiar to the pearl, which cannot be given to artificial ones.

Pearls being composed of concentric layers of nacre which are annual, must be of slow growth, and those of large size can only be found in full grown oysters.

I have engaged an intelligent person, who is on board one

of the ships employed in the pearl fishery, furnished with a diving bell, to attend to every thing connected with the present enquiry; and also to go down in the bell whenever it is used, paying attention to the objects that are seen, and noting the latitude and longitude, so that he may make the first beginning of a sketch of a map of the land under the sea.

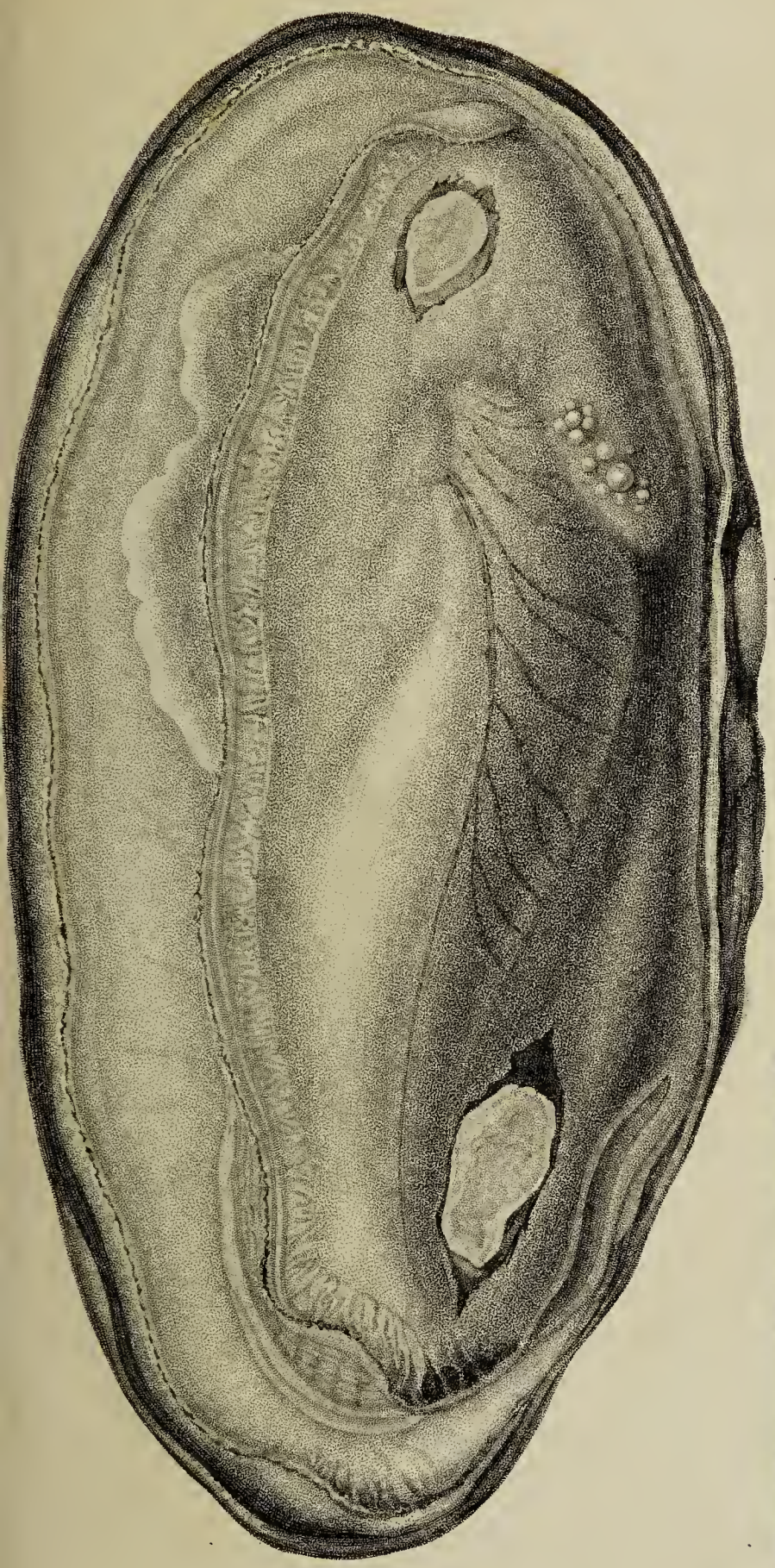
Upon stating to my friend, Mr. CHILDREN, of the British Museum, some of the above facts, he referred me to the ninth volume of the Philosophical Transactions for the following remarks, which accord in every thing with what I have stated.

Extract of a Letter from Hamburgh, by the learned CHRISTOPHORUS SANDIUS, *concerning the origin of pearls, Dec.* 1, 1673. *Translated into English.*

"The pearl shells in Norway do breed in sweet waters; their shells are like muscles, but larger. The fish is like an oyster, and it produceth a great cluster of eggs like those of crawfishes, some white, some black (which latter yet will become white, the outer black being taken off): these eggs when ripe are cast out; and being cast out, they grow and become like those that cast them: but sometimes it happens that one or two of these eggs stick fast to the sides of the matrix, and are not voided with the rest. These are fed by the oyster against her will, and they do grow according to the length of time into pearls of different bignesses, and imprint a mark both on the fish and the shell, by the situation conform to its figure."

In a second letter, Feb. 27th, 1674, in answer to one from

Fig. 1.

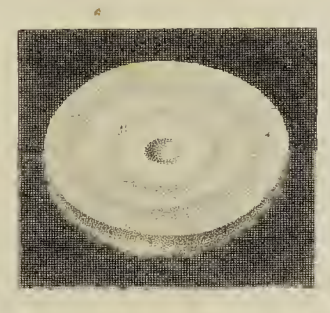


2.

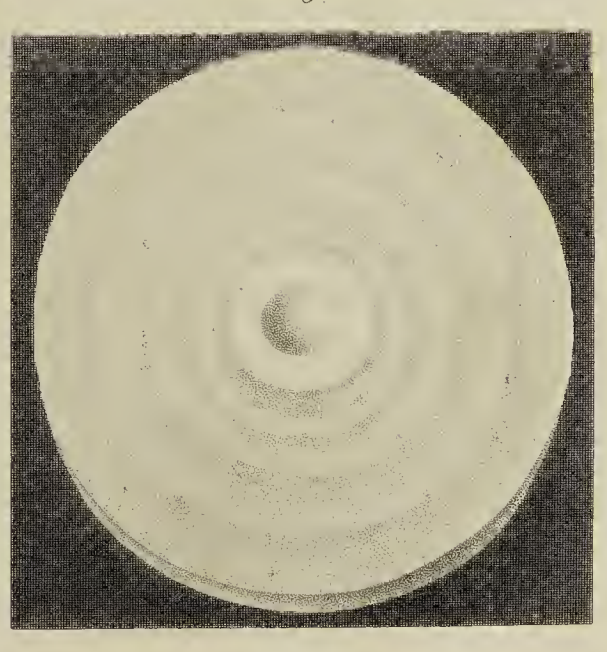
3.

4.

5.



6.



the publisher, desiring to know the ground on which the author had made that assertion.

" As to the authority I have to assert such an origin of pearls, I here declare that a certain Dane, called HENRICUS ARNOLDI, an ingenious and veracious person, having by his own experience found it so in Christiana, in Norway, with great seriousness assured me of the truth thereof."

PLATE XIII.

No. 1. A fresh water muscle, one shell removed, of the natural size.

The lining, with its attachment to the shell on which it lies, also the loose fringe upon its edge.

A portion of the foot exposed between the linings of the two shells.

A portion of the oviduct also exposed.

The lining detached from the shell removed.

The two muscles cut through which united the shells.

A cluster of small pearls lying on the outer surface of the ovarium, close to the liver.

No. 2. The above pearls magnified three diameters, firmly attached to the membrane on which they lie.

No. 3. A pearl bursting the bag in which the ovum was formed; five diameters.

No. 4. A pearl escaped from the bag; five diameters.

No. 5. Section of No. 4; ten diameters.

No. 6. Section of oriental pearl; ten diameters.

XXV. *On burrowing and boring marine animals.* *By* Edward Osler, *Esq.* *Communicated February* 15, 1826, *by* L. W. Dyllwin, *Esq.* *F. R. S.*

Read May 25, 1826.

The neighbourhood of Swansea offers remarkable facilities for observing the habits of the burrowing marine animals. Many Spatangi, innumerable Annelides, and a variety of bivalves are found on its extensive sandy shores; considerable beds of decayed wood are inhabited by Pholas candida; and the rocks at the western extremity of the bay abound with Lithophagi.

My chief object in this paper, is to explain the mechanism by which the boring and burrowing shell fish form their habitations; but as there are facts connected with the burrowing of other marine animals which are yet but imperfectly understood, I shall first advert briefly to the latter.

The Nereides found in sand bury themselves by the rapid undulating motion which they employ in swimming; and they travel through the sand with great facility by extending the anterior rings, and bringing up the posterior part of the body after them. Their progress is very much assisted by the action of their numerous bristly feet.

The Arenicola piscatorum of Lamarck (Lumbricus marinus of Linnæus), connects the naked with the sedentary Annelides. A viscid secretion exudes from the anterior half of

the animal to which the sand adheres; and hence, when the worm is dug up, this part is generally found to be covered with an imperfect arenaceous tube; within which the motions of the body are performed with perfect freedom, but which cannot be removed entire. This tube is in fact left behind in the progress of the animal, and forms a complete lining for the hole, which it supports, and keeps pervious through its whole length. The worm is thus enabled to ascend readily to the surface, and the water is admitted freely to the branchiæ.

A few of the anterior rings of the Arenicola progressively diminish in size, and each admits of being completely folded within the ring immediately behind it. Hence, when they are fully retracted, the anterior extremity of the animal is truncated abruptly; while it is extended to a regular cone when they are projected to a point just short of developing the mouth. This is its boring apparatus. The rings being retracted, the flat head of the Arenicola is directed against the sand; when the projection of the cone opens a passage for the body. The opening thus made would however be insufficient, and the branchiæ might be injured while forced through a narrow passage; but that the animal, immediately on completing the penetration, distends the penetrating rings very considerably. By the advance of the body the opening made for it is occupied; and the rings being thus received into each other, the cone is ready to be again projected. In the progress of the animal, the gluten which exudes from it cements the surrounding sand, and gives that support to the sides of the hole, without which it would immediately fall in.

The habits of the Terebella conchilega are so remarkable, and at the same time are so easily observed, that it is scarcely possible to read the minutely accurate description of it given by PALLAS, in his Miscellania Zoologica, without a feeling of surprise at his having overlooked them. It does not indeed appear that he had ever met with the animal in its natural situation, or that he was even aware of its propensity to burrow. His observations were made upon specimens thrown on shore by storms; and that which his figure represents is evidently a starved one.

But notwithstanding these disadvantages, his description is remarkably accurate and complete. Perhaps the surface which he has denominated "ventral," might with more propriety be considered as the "*dorsal*;" but this is too unimportant to be made a subject of dispute. The tentaculæ are much more extensile than he has stated; but this he could have known only by seeing them in action. If, when observing the motions of the animal, he had put some sand at the bottom of the vessel, an experiment, his neglect of which is the more extraordinary, since he employed it in his observations on the Pectinaria belgica, he would probably have completed his subject. His specimens must have been very weak and sickly indeed if they did not at least attempt to form a tube, and to bury themselves; for I have ascertained that a serious wound, and even the loss of the entire tail, does not prevent them from attempting, and even completing these tasks.

On these shores the Terebella conchilega is the most abundant of all the larger Annelides, with the exception of the Arenicola, and perhaps of the Sabellaria alveolata. They are

most numerous about midway between high and low water mark, where the sand is mixed with a large proportion of stones. By the shifting of the sands in storms, they are often buried to a considerable depth, and at other times have several inches of their tubes exposed. In the first case they speedily work up to the surface; in the other, the exposed portion of tube is soon broken off by the waves, or crumbles when dried by the sun. Their tubes are very long, and the animal remains towards the bottom, except when seeking its food. Hence specimens are to be obtained in general only in favourable situations, as it is almost impossible to dig up the whole tube.

As soon as the Terebella conchilega is removed from its tube, it throws itself into spiral folds. This contraction, which appears to be involuntary, is effected by the muscular bands, which extend the whole length of the ventral surface. The dorsal surface therefore constantly forms the outer or convex part of all the folds. If now it is placed under water upon sand, it straightens the body, and presently all the tentaculæ are seen in full action. They are extended in every direction, often to a length exceeding an inch and half; and they are seen dragging in small fragments of shells, and the larger particles of sand. These it places behind the scales projecting from the anterior and lower part of the head, where they are immediately cemented by a gluten which exudes from the animal; bending the head from side to side, while it continues to apply the materials of its tube, the conchilega has very soon formed a complete collar, which it employs itself to lengthen regularly from every part of its circumference with a persevering activity highly interesting. To fix the

different fragments compactly, it presses them into their places with the erected scales, at the same time retracting the body a little. Hence, the fragments being raised by the scales, are generally fixed by their posterior edges ; and thus overlaying each other, often give the tube an imbricated appearance.

When the tube is from half an inch to an inch in length, the animal proceeds to burrow ; directing its head against the sand, it penetrates by a slight extension of it, effected by the circular contraction of some of the posterior rings, which presses the viscera forward. The penetrating force is very inconsiderable, because the animal having to form its tube as it descends, can advance but slowly. It is now of course obliged to avail itself of the materials with which it may happen to come into contact. Its progress is marked by the gradual disappearance of the tail, which continues to advance into the tube till the whole has entered. Soon after the conchilega is found to have turned within the tube, and its head appears at the surface. This motion is clearly effected by the longitudinal muscles (fig. 1, *c. c. c.*), which have been stated to throw the animal into folds, and which must also raise the tail to the surface whenever the fæces are to be discharged.

In summer the whole task is completed in four or five hours ; but in cold weather, when the animals are more sluggish, and the gluten appears to be secreted in smaller quantity, their progress is slower in proportion.

The extremity of the tube is generally ornamented with a number of branches, composed of single rows of sandy or shelly particles. These are formed accidentally from time

to time, by the adhesion of sand to the tentaculæ when thrown out in quest of prey. The gluten exuding from the tentaculæ cements the grains to each other and to the tube. I have very often known these branches to be formed by the animals I kept in confinement.

The Spatangus buries itself in the sand by the action of its bristles: those on its under surface are short and thick, diverging from the centre towards the circumference; and at their extremities becoming expanded, flattened and curved, with the convexity downward. Around the sides they are straight, longer, but much slighter than the others, diminishing in thickness towards their extremities; and, in the state of inaction, resting flat upon the body, with their points directed backward. A few long stout spines arise in a crescent from the back, which converge till their points meet. All are attached to the crest individually by a small muscular papilla.

The flat bristles have a limited rotatory motion, and admit also of being moderately depressed: the lateral ones are extended nearly to a right angle with the body, and are directed downward, even beyond the perpendicular: the long dorsal spines admit only of being erected to the perpendicular, or reclined backward to a moderately acute angle with the body.

The operations of the animal are best observed by placing it on the sand immediately after it has been dug up, as it soon perishes out of the water The motion of the short flat bristles forms in a little time, a quicksand under it, into which it sinks by its own weight so far as to enable the lowest of the lateral bristles to act upon the sand. These are

directed downward, raised, and then returned to the side, to be again depressed and elevated. Thus they co-operate with the flat bristles in loosening the sand, while they throw up that which has been reduced to a semi-fluid state; and, at the same time, act in some degree as levers to depress the Spatangus with a force greater than it could have derived from its weight alone. As the animal sinks, more of the bristles are enabled to act, and its progress becomes more rapid; while the semi-fluid sand which it throws up flows slowly back upon it and covers it, when it has sunk below the level of the surface. The long dorsal spines prevent the sand from closing completely, and preserve a small round hole, by which water is admitted to the animal, and which marks its situation.

The burrowing of Bivalves into sand may be observed at all times by persons near the coast: all that is necessary is to place a few of them on a bed of sand, covered with sea-water. The animals, which from their small size or the little depth at which they reside, are particularly liable to be exposed, will generally burrow readily; but the large species will scarcely attempt to bury themselves except in the very young state. It may be proper to observe, that those thrown on shore by storms will very rarely attempt to burrow; and that there is a considerable difference in this respect, even in the animals just taken from their natural situations; some burying themselves immediately, while the greater number will remain inactive for two or three days.

When the animal would burrow, it projects and elongates the foot, distending it until every part of it, except the point, appears semi-transparent. Directing its point downward, it

insinuates it into the sand until it is nearly buried. A circular motion is now given to the shell, by which its anterior point is quickly brought nearly into contact with the foot, and immediately returned to its former situation. It thus moves on the foot, as on a fulcrum, with a see-saw motion. The foot, which had been partially retracted, is again gradually projected as far as possible into the sand, when the circular motion of the shell is repeated. When the animal is moderately active, the strokes follow each other at intervals of 20 or 30 seconds. The apparent progress is at first but small; the shell, which is raised on its edge at the middle of the stroke, falling back on its side at the end of it: but when the shell is buried so far as to be supported on its edge, it advances more rapidly, sinking visibly at every stroke, till nothing but the extremity of the syphon can be perceived above the sand.

The instinct which directs the animal thus to procure a shelter, operates at the earliest period of its existence. On examining a Mya truncata, dug up on the preceding day, and which, when grown, will not attempt to burrow, I found two young ones, entangled in the folds of cuticle at the extremity of the syphon, scarcely more than a line in length, and apparently but just excluded. Being placed on sand in a glass of sea-water, they buried themselves immediately.

The motions by which the animals burrow are effected by two pair of muscles, which arise from the shell, and are inserted into the foot. The anterior muscles, (fig. 2, *a*) arise at the upper margin of the anterior adductor, and uniting immediately below the mouth, pass down together to their insertion. The posterior (fig. 2, *b*), take their origin

at the upper margin of the posterior adductor; and passing forward and downward, meet near or upon the body of the animal, and advance together along its posterior edge. The foot itself is embraced by fibres given off from all these muscles.

A tube opens just within the mouth, going off nearly at a right angle with the œsophagus: it proceeds in a curvilinear direction through the body, immediately above the foot: its course is indicated in the figure by the dotted line at *c*. It is this tube which conveys the water by which the foot is distended. In some of the largest species, as Cyprina islandica, a transverse section of the foot shows a single chain of pores along its whole length, which communicate with the principal tube, and transmit the water to the cellular portion of the foot.

It is scarcely necessary to detail the action of these several organs. The point of the foot being solid, is adapted to precede the distended portion in penetrating the sand. A viscid matter is secreted from the surface of the foot when distended, which, by agglutinating the sand around it, fixes it more firmly, and thus augments the force of the stroke. The operation of the anterior and posterior muscles of the foot cannot require explanation.

The locomotive Bivalves travel by a series of motions precisely similar to those employed in burrowing, and which are effected by a similar arrangement of muscles. The foot, instead of being pointed downward, is projected horizontally just beneath the surface of the sand; and the shell is brought forward by the successive contraction of the anterior and the posterior muscles. The Venus gallina is particularly dis-

posed thus to travel, and indeed is generally to be found most readily by the furrow which it has ploughed up in its progress. In the summer it is met with on these shores in considerable numbers, above a furlong from low-water mark; though at other seasons it is rarely seen, excepting after storms. Anodonta cygnæa offers an example of the same kind. It is thus, also, that Cyclas cornea crawls over a smooth surface, fixing itself by a viscid gluten, which exudes from the elongated foot in such quantity, that the animal in its progress leaves a silvery track like that of a snail. I have repeatedly seen small ones crawl up the side of a glass, and even support themselves on the surface of the water by a broad filament of this gluten extended from the side of the vessel.

Although not habitually residing under the sand, the Buccinum undatum is entitled to a place among the burrowing marine animals. It is often found to have completely buried itself, apparently, for shelter; and there are very strong reasons for suspecting that it habitually burrows in pursuit of its prey.

As in the Bivalves inhabiting sand, its foot is the instrument of penetration; and like them, it has the power of distending this organ to a size, nearly, if not quite equal to that of the shell. A section of the foot shows it to be divided into two nearly equal parts; the powerful muscle, which extends from the operculum to the spire, forming the upper, or posterior half, and a cellular spongy mass constituting the remainder. The lower surface of this portion is the disc on which the animal crawls; and being considerably longer than the muscle, it is folded upon itself, when retracted

within the shell; and the operculum lies flat above it when it is projected and extended. A transverse section of the foot near the part where it joins the body, shows four considerable tubes penetrating the spongy portion, and very near each other; three of which are in a line parallel to, and almost in contact with the muscle; the fourth, a little below the middle one of the three. By a series of transverse sections of the foot, parallel to the operculum, we are enabled to trace these tubes; and to ascertain that they become rapidly smaller as they advance, until they are quite lost; the longest of them not admitting of being traced quite to the operculum. All these tubes are given off at the extreme anterior point of the thorax from a considerable one, (fig. 3, *l*,) which, being situated under the muscular floor of this cavity, takes a direction to the right side, and running just within the origins of the muscles of the trunk (*k*) passes out of the thorax, nearly in contact with, and on the right side of the œsophagus. It terminates nearly midway between the heart and the rectum, (*m*) opening into a considerable cavity, which has the liver underneath, and the membrane enveloping the spire above it. When the animal contracts the distended foot, the water is seen to flow out between the mantle and the shell on the right side. The tube and cavity are easily inflated by a blow-pipe introduced into one of the tubes of the foot.

The moderately distended foot can scarcely be retracted within the margin of the shell; and when fully injected, it is elastic, and of a very large size. The cavity which it opens into the sand is therefore fully adequate to receive the shell, which is drawn down into it by the contraction of the muscle of the spire. From the attachment of this muscle, the spire

is the part more directly acted upon, and which is depressed in the greatest degree. Hence the notch is always uppermost, and the Buccinum, when completely buried, is enabled to communicate with the water by its respiratory syphon.

The Pholas can be observed to bore only in the young state. They are found completely buried, when so minute as to be almost invisible; and the rapidity of their growth for the first few weeks, compels them to exert themselves perseveringly in effecting the enlargement of their habitation. Hence if a few of the young animals, which may be procured in abundance very early in the spring, are placed in a pan of water upon some of the substance which they had inhabited, they will, in a short time, begin to work, and continue to do so, at intervals, for two or three days; thus affording ample opportunity for observing the process.

The only species of Pholas now found on these shores, and consequently, the only one whose habits I have had an opportunity of observing, is P. candida. It is, therefore, to this that my observations must be considered to apply more directly.

The Pholas differs in many particulars from all other Bivalves; and its peculiarities of structure are so essentially connected with its method of boring, that a full description of them is necessary.

From the syphonal, or posterior extremity of the valves, their dorsal edges are directed inward, till they meet at the hinge, whence they again separate; and, finally, converge towards their points. There is, consequently, a triangular gape behind the hinge, which is lost by bringing the dorsal edges into contact; and an egg-shaped one before it, which

becomes an oval, when the anterior points of the valves are approximated. The ventral margins have also a considerable convexity. At a fourth of the length of the valves from their anterior points, their edges are rolled in to form an umbo,which is covered with a reflected semi-pearlacious fold; and at the inner part of this is a round, prominent, cartilaginous spot, the point of union between the valves. In P. candida, a short process is given off from beneath this spot in the left valve, (fig. 4, *a*) and a thin, flat ligament from a corresponding tubercle in the right, which, passing obliquely backward, meet at the middle of their length, and are thence united to their extremities. The connection thus obtained is so weak, that it is extremely difficult to remove the fish without separating the valves: it is, indeed, only strong enough to make the hinge the constant centre of motion.

A long, thin, curved process is given off from beneath the umbo, (fig. 4, *b*). Its convexity corresponds with that of the valve, and its direction is a little obliquely backward. I believe this process to be characteristic of an animal which bores mechanically by employing its shell as a rasp. The anterior and lower portion of the shell is thicker than any other part, and its surface is armed with much stronger spines; and it is this portion which the Pholas employs in boring.

The Pholas is quite destitute of the elastic ligament which connects and expands the shell in other Bivalves. Its connections are chiefly muscular, and its motions are effected exclusively by the action of muscles. It is evident that, by this arrangement, the greatest possible freedom of motion is secured.

The Pholas is provided with four sets of muscles, in addition to those belonging to the syphon. The posterior adductor, (fig. 4, *c*,) is a flat muscle, connecting the valves nearly midway between the hinge and the extremity of the shell, and having its attachments at about $\frac{1}{8}$ of an inch within its dorsal margins. It lies so superficially, that its action is seen when the animal employs it in boring. The anterior adductor (*a*) is attached to the reflected folds which cover the umbo. It extends from a point a little before the hinge, nearly to the anterior extremity of the shell, and is covered by the accessory valve. The ventral margins are connected by muscular fibres, from the opening in the mantle through which the foot is projected, as far as the origin of the syphon. A pair of muscles, which may be termed "lateral," arise from the points of the long, hooked processes, which, becoming fan-shaped, as they pass over the body, are inserted into the sides of the foot.

The offices of these muscles are peculiar. The shell is closed, not by the adductors, but by the fibres which connect the ventral margins of the valves; and it is opened by that part of the anterior adductor which lies nearest to the hinge, and which thus performs an office analogous to that of the ligament in other Bivalves. The other portion of this muscle antagonizes the posterior adductor. By its contraction, the anterior points of the valves are brought into contact, and their dorsal margins separated as widely as possible. The action of the posterior adductor reverses this state; and, in uniting the dorsal margins, expands the anterior and armed portion of the shell. The foot of the Pholas, like that of the Gasteropodes, is a flat disc, by which the animal can attach

itself firmly. When it is thus fixed, the lateral muscles, acting in an oblique direction, will raise the posterior end of the shell, and press its armed extremity forward and downward: or, if one of them should contract more strongly than the other, it will bring down the corresponding side of the shell, which will be restored to its erect position by the action of the opposite muscle.

The Pholas has two methods of boring. In the first, it fixes itself by the foot, and raises itself almost perpendicularly, thus pressing the operative part of the shell upon the substance to which it adheres: it now proceeds to execute a succession of partial rotatory motions, effected by the alternate contraction of the lateral muscles, employing one valve only, by turning on its side, and immediately regaining the erect position. I have observed that this method is almost exclusively employed by the very young animals; and it certainly is particularly adapted for penetrating in a direction nearly perpendicular; so that they may be completely buried in the shortest possible time. It may be observed, that the posterior extremities of the valves are much less produced in the very minute Pholades than they afterwards become; and thus the time required to complete a habitation is still farther diminished.

But when the Pholades have exceeded two, or, at the utmost, three lines in length, I have never observed them to work in the manner I have described: the altered figure of the shell, and the increased weight of that part of the animal behind the hinge, would prevent it from raising itself so perpendicularly as at first, independent of the narrow space which it now occupies. In the motions required to enlarge

its habitation, the adductors perform a very essential part. The animal being attached by the foot, brings the anterior points of the shell into contact. The lateral muscles now contract, and raising the posterior extremity of the shell, press its operative part against the bottom of the hole; and, the moment after, the action of the posterior adductor brings the dorsal margins of the valves into contact, so that the strong rasp-like portions are suddenly separated, and scrape rapidly and forcibly over the substance on which they press. As soon as this is effected, the posterior extremity sinks, and the stroke is immediately repeated by the successive contraction of the anterior adductor, the lateral, and the posterior adductor muscles.

The particles rubbed off, and which, in a short time, completely clog the shell, are removed in a very simple manner. When the projected syphon is distended with water, the Pholas closes the orifices of the tubes, and retracts them suddenly. The water which they contained is thus ejected forcibly from the opening in the mantle; and the jet is prolonged by the gradual closure of the valves, to expel the water contained within the shell. The chamber occupied by the animal is thus completely cleansed; but, as many of the particles washed out of it will be deposited before they reach the mouth of the hole, the passage along which the Pholas projects its syphon is constantly found to be lined with a soft mud.

As a British animal, I believe the Teredo to be nearly, and probably quite extinct. In the harbours of Falmouth and Plymouth, where, some years ago, it was so abundant, it is no longer to be found. In the Royal dock-yard at Devonport,

I was shown two specimens which had been taken out of a pile many years before, but they were treasured as a curiosity; and I was assured by Mr. CHURCHILL, the master shipwright, that at present they are never met with. The shipping of Swansea trade to every part of the kingdom, and we have nearly four thousand arrivals in the year, chiefly from coasting voyages; but, though very few of the vessels are coppered, we never see the Teredo.

Two causes may be assigned for this complete destruction, either of which appears sufficient to account for it. An imported shell-fish, if pelagic, may naturalize itself permanently; but where, like the Teredo, it always resides near the surface, and often in situations which are left dry during the ebb, it is necessarily affected by changes of temperature; and the animal which is naturally the inhabitant of a warm climate, will be destroyed by a severe winter. It is probable that the Teredo was formerly preserved only by occasional importations, which are now prevented by the general use of copper sheathing.

Independent of causes connected with climate, the Teredo would diminish, and become extinct for want of a nidus. Where piles had been destroyed by them, care would be taken to preserve the new ones from their ravages by a covering which the young animals cannot penetrate. Valuable timber would not be placed within their reach; and wood, neglected because useless, is generally too small to contain a large Teredo. They would therefore perish from confinement before they were full grown. The Pholas dactylus, which, but a few years since, was very numerous in Swansea bay, has been lost here from this cause. The large beds of peat-wood,

into which they formally burrowed, were gradually broken up by the sea, until they became so thin that the Pholades, before they were full grown, were stopped by the gravel and perished.

Having been unable to procure the living animal, I can offer to the Society only the results of my observations on some specimens sent me from the Mediterranean.

Every peculiarity of structure upon which the boring power of the Pholas has been shown to depend, exists in an equally marked degree in the Teredo. We find the thin and obliquely placed ligament of Pholas candida, the superficial muscle connecting the valves before the hinge, the posterior adductor and the muscles passing from the lateral processes to be inserted into the foot. The muscles indeed vary in their relative size, because their size is proportioned to the force they are required to exert, which differs in the two animals. Most species of the Pholas have comparatively large shells, and burrow into substances of but a moderate degree of hardness; while the shell of the Teredo is very small, and it penetrates the hardest wood. The office of the anterior adductor being only to close the valves, its size is in proportion to the weight of the shell. It is by the contraction of the posterior adductor that the animal effects the stroke; and the force of this muscle will therefore depend upon the resistance to be overcome. Hence, in the Teredo, the anterior adductor is much smaller than in the Pholas, while the posterior adductor is far more powerful in proportion. The lateral muscles are more distinct than in Pholas candida, but they are very short. It is not probable therefore that

the Teredo can bore, as the young Pholades have been described to do, by the action of these muscles alone.

The posterior adductor is attached to a large process in each valve, which, in the common Teredo is a perpendicular oval plate, resting against the dorsal margin of the valve, and formed by a prolongation and expansion of the tubercle at the hinge. About a third part of it is concealed within the shell, and the upper margin is rolled outward at its anterior end. In the Teredo palmulatus this process is nearly triangular with the apex to the hinge; and is formed by an extension of the shell itself, of which it is a mere beaklike projection. Both these processes are represented in the drawings.

If all the boring shell fish penetrated mechanically, it would be reasonable to expect that their powers should evidently be in proportion to the hardness of the bodies which they inhabit: this is found to be the case in the different species of Pholas; but the Lithophagi, which would have the greatest mechanical resistance to overcome, appear to be destitute even of the smallest mechanical force. They have nothing which in the slightest degree resembles the boring apparatus of the Pholas. On the contrary, their shell, as in the bimusculous Conchiferæ, is expanded by a powerful elastic ligament, and closed by two large round internal adductors. The valves in most of the species shut close, and the foot is not an instrument adapted for firm adhesion.

Four species of Lithophagi are found in the neighbourhood of Swansea; but as the Saxicava rugosa (Mytilus rugosus of LINNÆUS,) is so abundant, that it may be procured in any quantity, I shall take it as the type of the family.

The general structure of Saxicava rugosa is very similar

to that of the Bivalves which burrow into sand. The number and attachments of its muscles, as well of the adductors as those connected with the foot, are exactly the same. The foot is directed nearly horizontally forward, and in its state of contraction is very small, but it admits of being distended and much elongated: I have repeatedly observed it extended in young animals to the length fully equal to that of the shell: when in this state, it is seen to contain an opaque white line or tube, which passes forward from the part where it joins the body, and terminates abruptly on the under surface near its extremity. This tube becomes black when the animal has been preserved in a saturated solution of muriate of soda. The mantle is of a greyish white colour, opaque, and remarkably thick. A byssus arises from a longitudinal slit in the posterior part of the base of the foot; and passing out with this organ through the opening in the mantle, attaches the animal to some part of its hole.

I have had an opportunity of observing the young of Saxicava rugosa, before they had begun to bury themselves. The activity which they displayed was a perfect contrast to the extreme sluggishness of the older animals. They travelled over the stone by extending and fixing the foot, and then bringing the shell forward by the action of its anterior and posterior muscles, exactly in the same manner as the locomotive Bivalves. In their progress they turned the foot in different directions almost at every step, appearing to examine the surface of the stone for a suitable spot on which to fix themselves. At length they attached the byssus, and from that time no motion could be observed in the shell. I placed one of these young animals in a valve of Mya trun-

cata; it crawled about almost without intermission for the greater part of two days, and at length fixed itself in a crevice by the side of the ligament. During the five subsequent days it was perfectly quiescent: it perished at the expiration of that time, apparently destroyed by the putrefaction of the ligament. I have taken many hundreds of the animals from their holes, and kept them in confinement till they died, but never saw one of them attempt to change its place.

It is evident that the Saxicava does not bore like the Pholas, by a rotatory motion, for the hole is not quite round, and its smallest diameter is not equal to the depth of the Saxicava, from the hinge to the ventral margin. The animal therefore has not room to turn itself; and its attachment by a short byssus imposes an additional restraint upon it: indeed, an examination of its muscles is sufficient to show that they cannot effect a rotatory motion. The only boring motion which can be supposed to be given to the shell is that effected by the action of the muscles of the foot; that, in fact, by which a Bivalve buries itself in the sand; but this, although so well adapted for travelling over a smooth surface, or for burrowing into a substance penetrable by the foot, would be ineffectual here, because the animal being already in contact with the rock, the foot cannot be projected to form a fixed point beyond the shell. Even were it otherwise, the texture of the shell is so soft, that it could make no impression upon the stone without being itself acted on; and the effect of this would be permanent, because superficial injuries of the shell are never repaired. But nothing of this kind is met with. I have even found a Saxicava fixed between two others, which was so compressed that it was quite flat, and little more than

a third of its proper thickness; yet neither of the three showed the slightest mark of friction, and the cuticle of the sides in contact was as perfect as usual.

But independent of the presumption afforded by the softness and smoothness of the shell, and by the absence of any arrangement of muscles which might employ it with effect had it been strong enough to act on hard stone, it is easy to collect facts affording ample proof that the shell cannot be the instrument of penetration. I have a specimen of calcareous stone of extraordinary hardness, containing small masses of silex, some of which project into the holes formed by Saxicava rugosa, and Venerupis irus. The lime has been smoothly cleared around the base of these projecting portions from situations with which the shell could not possibly have come into contact. In another specimen, in which the lime is mixed with a large proportion of clay, there is a small round stratum of stone entirely argillaceous, and not one-twentieth of an inch in thickness. The lime surrounding this stratum has been removed by three Saxicavæ, which have bored down upon it from different directions. The shell of one of them remains in its hole, and shows that the progress of the animal was arrested by the stratum long before its death. There is a deep groove across one valve, in which the stratum is nearly buried; and which has evidently been caused, not by friction against the stratum, but by the growth of the shell on each side of it; this is shown in fig. 6.

If additional proof is required, it is supplied by the fact that many naked animals of the softest texture form their habitations in limestone. The boring Annelides are innumerable in calcareous rocks, and are found to attack every marine

shell almost as soon as it has acquired sufficient thickness to afford them a nidus. They may, indeed, be considered to perform the very important office of destroying shells when they become useless; thus preventing accumulations which, in a few ages, would fill every harbour. The thick oyster shells on these coasts are always occupied by a kind of sponge. It is a fibrous yellow pulp, filling a number of irregular cells, which open freely into each other, and eventually occupy and destroy the whole shell. The cells communicate with the surface by a number of small, round, and polished holes, each of which is occupied by a tough, and apparently inirritable tube, which adheres firmly to its circumference. These holes have been observed by every conchologist, and were supposed by MONTAGU to be formed by Mya bidentata. The yellow substance is not peculiar to the oyster, nor is it disease; for I have met with it in dead shells, and have found it extended to the surface through a considerable thickness of coralline. The penetration of all these naked animals leads irresistibly to the conclusion, that a shell is not essential to the boring process; and it would be inconsistent with the simplicity observable in every part of nature, to suppose that she has provided such different means for accomplishing the same end.

Whatever may be the instrument of penetration, it is situated at the lower and anterior part of the animal. Where the Saxicavæ are numerous, their holes communicate very freely; and it is common to meet with one which has attached its byssus to another. In this case, it is always found that the shell of the second has been acted on in a direction, and to an extent, which corresponds with the range of the foot of

the assailant. When the animals meet laterally, they become compressed and distorted in the course of their growth, but their shells are never injured.

If the Lithophagi perforate mechanically, the shell and the foot are the only instruments which they can possibly employ. It has been shown that the shell is not adapted, or even required, for this purpose; and it must be quite unnecessary to attempt to prove that a stone cannot be rubbed away by a mere vesicle, like the distended foot; especially when it is observed that the syphon, which is so much thicker and stronger, is preserved from the effects of friction by a particular strong cuticle. To ascertain that the mechanical powers of the animal are quite unequal to make an impression upon a stone, would of itself almost justify the presumption that the task is effected by a solvent.

But the theory of a solvent does not rest on mere negative proof. It appears impossible to explain, on any other grounds, the animal's exclusive choice of calcareous matter; a choice evidently depending on its inability to penetrate stones of a different nature. I have already alluded to specimens, in which silex projects into their holes, and in which a very small stratum of insoluble stone has arrested the progress of the Saxicava. An exception may perhaps be taken to the hardness of the silex, though it certainly is not harder than the stone in which it is imbedded; but I am unable to perceive how the fact connected with the other specimen is to be explained away. It may be observed too, that in this specimen the holes, instead of being smooth, and almost polished, as usual, are uniformly rough; presenting, when examined under a glass, precisely the fretted appearance which

should be produced where the soluble portion of a stone has been dissolved, and the insoluble particles are left projecting from the surface; and even stronger facts may be adduced. Specimens are at all times to be obtained in which the shell has been extensively acted on by others; while the cuticle, which had necessarily been exposed to the same agent, remains uninjured, and overhanging the breach.

In MONTAGU's Testacea Britannica, it is stated on the authority of PULTENEY, that Venerupis irus (Donax irus of LINNÆUS) has been found in clay; and the author affirms that he himself possessed specimens of Mya pholadia in stones not calcareous. Facts presenting so serious an exception to the general habits of the animal to bore into lime, would be fatal to the theory of a solvent, did they not admit of full explanation. The young animals, in seeking a convenient spot, almost invariably fix themselves in holes or crevices which afford them immediate shelter. Hence, they are occasionally found lodged among the roots of fuci; and they will sometimes find a shelter in stone, upon which they are unable to act. I have met once with a Mya distorta, and repeatedly with Saxicava rugosa and præcisa, lodged in soft argillaceous stone; but in every such case the hole had clearly been made by a pholas, the remains of whose shells were generally found in it more or less dissolved by the Saxicava. The specimens I observed were in masses of rock, honeycombed by the pholas; which, having probably been brought among ballast, have for many years formed part of the boundaries of the oyster banks in this neighbourhood, and which are within a very short distance of rocks abounding with Lithophagi. I have often found Mytilus edulis, and

occasionally Mya truncata, in similar situations. These are the only circumstances under which I have found the Lithophagi inhabiting insoluble stones, and such an exception confirms the general rule.

I have stated, that where the Saxicavæ are abundant, their holes very often communicate; and that their shells are acted on when exposed to the foot of another. On examining a considerable number, taken indiscriminately from the same rock, I have found that the shells of more than half had been thus injured. As long as the injury is superficial, no attempt is made to repair it; but when the shell is nearly or quite penetrated, the breach becomes filled, not with new shell, but with a firm yellow substance, which is insoluble even in a strong mineral acid. It would be difficult to conceive a fact short of absolute demonstration, which could give a more decisive support to the theory of a solvent. A peculiar provision is given to the animal to preserve it from destruction by an injury, to which it is particularly exposed. The supposition of mechanical penetration would require us to believe that a newly formed substance, much softer than that which has been destroyed, can stop the progress of the mischief, and even repair it, under the continued application of the original destructive force.

I have delayed the communication of this paper for many months, from a wish to complete the subject by detecting the solvent; but every experiment I have made for this purpose has been quite unsuccessful. Litmus paper applied to every part of Saxicavæ just taken from their holes, shells stained, and sea-water tinged with the same test, in which animals of every size were kept till they died, gave no

indication of the presence of an acid. The water in which a mass of rock, containing above an hundred Saxicavæ had been kept for a week, afforded a precipitate, when treated with oxalic acid, only equal to that obtained from the same quantity of common sea-water. To explain the failure of these experiments, it may be observed, that where the Lithophagi happen to be lodged in situations which afford them sufficient room and shelter, they make no attempt to enlarge their habitation. Thus, Saxicava præcisa is more frequently found among groups of Serpulæ than in a hole which it has excavated; and I have obtained full grown specimens of Hiatella arctica (Solen minutus of Linn.) attached by the byssus to a Pecten. It may therefore be presumed that the solvent is secreted only when its agency is required; and this would sufficiently explain why a free acid cannot be detected in the animal. Litmus, in the smallest quantity, acts as a poison upon them. The animals exposed to it remain with their syphons half projected, which they do not attempt to retract on being touched, and perish in a few hours. If an increased quantity of calcareous salts could be detected in water in which they had been kept, the experiment would be a decisive one; but when it is considered that the animals live in the open sea, and are to be obtained only at low tides, it is not to be expected that they will work when confined in a small vessel, and deprived of food.

Had the question been previously balanced, our inability to detect a solvent would justify strong doubts of its existence: but while all the facts connected with the natural history of the Lithophagi afford a strong and consistent support to the theory of a solvent, and are opposed as decidedly

Fig. 1.

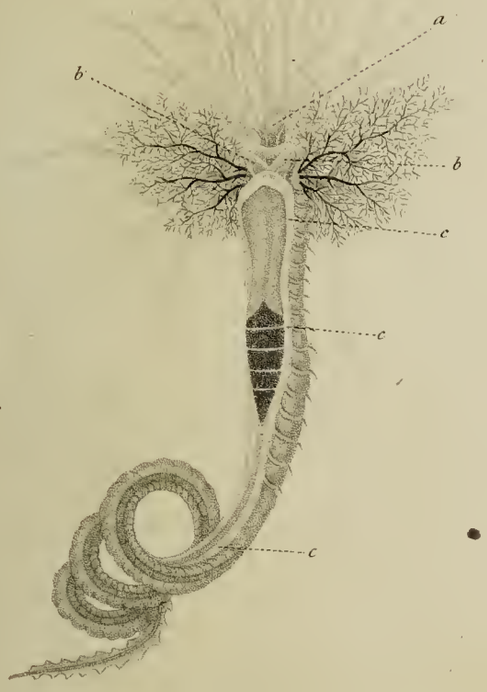


Fig. 2.

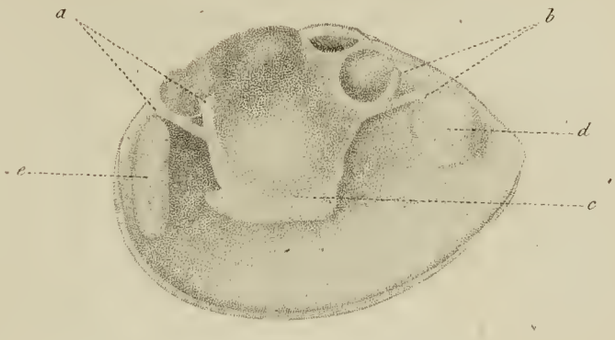


Fig. 3.

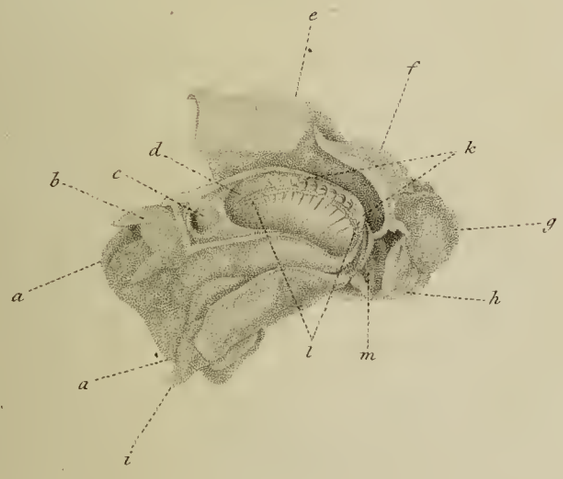


Fig. 4.

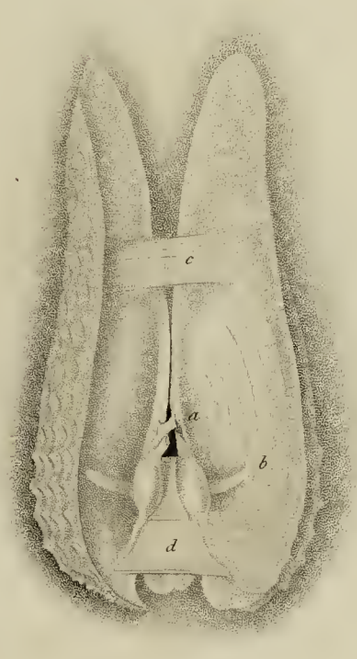


Fig. 5.

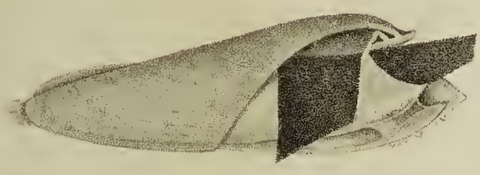


Fig. 6.

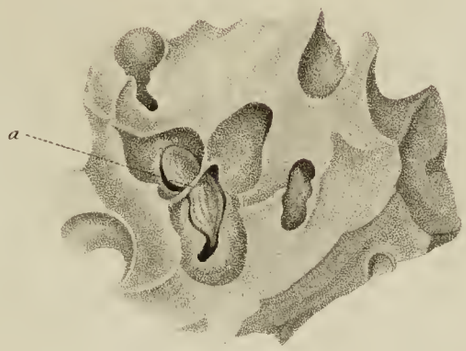


Fig. 7.

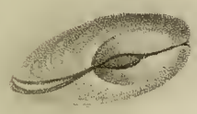


Fig. 8.

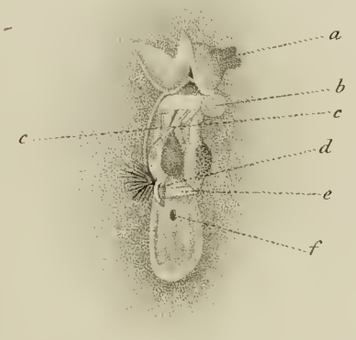


Fig. 9.

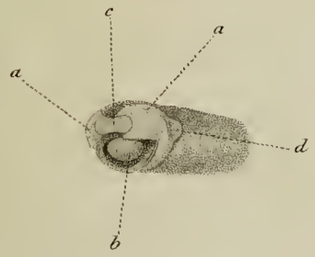


Fig. 10.

to the supposition of penetration by a mechanical force, the failure of the experiments cannot be considered to militate very strongly against the only inference to be drawn from the facts. I regret my inability to offer the last decisive proof, which would have set the question finally at rest; but I feel persuaded that, should future enquiries be successful in ascertaining facts which have escaped my observation, they will tend to substantiate the conclusion which I have been led to support.

EXPLANATION OF THE FIGURES PLATES XIV, XV.

Fig. 1. The Terebella conchilega, as it appears when proceeding to collect materials for its tube; *a*, the mouth; *b b*, the larger scales below the head, with which it fixes the materials of its tube; *c c c*, the course of one of the muscles by which the animal throws itself into folds. In specimens, which have been deprived of food for a few days, the muscular fibres become beautifully distinct.

The figure given by PALLAS, and which is I believe the only one we possess, is not only drawn from a bad specimen, but is so very carelessly engraved, as to be inaccurate in almost every respect.

Fig. 2. A burrowing bivalve; Lutraria compressa: the left valve, syphon, mantle, and branchiæ removed.

a, The anterior, and *b*, the posterior muscles of the foot; *c*, the course of the tube by which the foot is distended with water; *d* and *e*, the adductors.

Fig. 3. The animal of Buccinum undatum; part of the

spire, and the branchiæ removed; the mantle turned to the right side; the upper part of the thorax cut away to expose its cavity, from which the boring trunk and salivary glands have been taken.

a a, The foot; *b*, the head; *c*, a kind of platform raised above the floor of the thoracic cavity, on which the point of the boring trunk rests, and which leads to the mouth; *d*, the cavity of the thorax; *e*, the mantle; *f*, the rectum; *g*, the stomach; *h*, the heart, thrown below, and to the right side of its natural situation, to allow the opening of the tube to be seen; *i*, the respiratory trunk; *k*, the origins of the muscles of the boring trunk; *l*, the course of the tube by which the foot is supplied with water; *m*, its termination.

Fig. 4. Pholas candida, one-half larger than nature. The fish has been removed, leaving only the adductors, and the shell is expanded excessively to show the hinge.

a, The ligament and process to which it is attached; *b*, the lateral process; *c*, the posterior, and *d*, the anterior adductor.

Fig. v. Pholas candida; the posterior part of the right valve removed to show the lateral muscle arising from the point of its process, and passing to its insertion into the side of the foot. Its extreme fibres extend beyond the foot on each side, and, uniting with the corresponding fibres of the opposite muscle, embrace the body. This muscle is so blended with the general covering of the body, that it cannot be seen, even with a glass, except at its origin; but its firmness makes it easy to raise it by dissection, and to display it, as in the figure, on a piece of dark paper.

Fig. vi. A mass of impure calcareous stone, containing a

small argillaceous stratum, which a Saxicava rugosa has been unable to overcome.

a, The stratum confining the shell.

Fig. 7. The shell of a Saxicava rugosa which has been injured by another. The umbo has been removed, but the ligament and the cuticle, which extends from it to the anterior extremity of the shell, remain uninjured.

Fig. 8. The animal of Saxicava rugosa; the branchiæ removed, the mantle divided and thrown back; *a*, the syphon; *b*, the posterior adductor; *c c*, the posterior muscles of the foot; *d*, the foot, with its tube and byssus; *e*, the anterior adductor; *f*, the opening in the mantle for the foot. The anterior muscles of the foot are concealed by the body.

Fig. 9. Teredo palmulatus; *a a*, the boring shells; *b*, the foot; *c*, the anterior adductor; *d*, the process to which the posterior adductor is attached.

Fig. 10. Teredo communis; the boring shells separated to show the posterior adductor. *a*, The ligament; *b*, the process to which it is attached; *c*, the posterior adductor attached to one of its processes; *d*, the corresponding process in the other valve.

XXVI. *An account of some experiments relative to the passage of radiant heat through glass screens. By the Rev.* BADEN POWELL, *M. A. F. R. S. of Oriel College, Oxford. Communicated March* 9, 1826.

Read June 1, 1826.

(1) IN a former Paper, communicated to the Royal Society, and which has been honoured with a place in the Philosophical Transactions for 1825, I attempted an investigation of the distinctive characters of two species of heating effect, in which particular reference was made to the action of transparent screens. In the present communication, my object is to examine a further point belonging to that part of the subject; and to which, as well as the former enquiry, I have been led, from considering the results obtained by M. DE LA ROCHE. The investigation given in my former paper proceeded upon the assumption, that simple radiant heat is incapable of permeating glass by direct transmission when the source is below luminosity: and the conclusion deduced from my experiments went to show, that that portion of the heat which is intercepted above luminosity, is simple heat, unaltered except in intensity, whilst that which is transmitted is of a different kind.

That this assumption, at least under all ordinary circumstances, is warranted by most decisive experiments, I conceive sufficiently certain. It appears to me, however, that

in reference to its strict universality, some further enquiry is necessary. The general inference respecting transmission, deduced from DE LA ROCHE's experiments, has, I conceive, been satisfactorily explained by mine; but there is one of his conclusions to which my principle does not apply (except in a particular case), and which might seem to afford considerable ground for the idea of an actual radiation through glass, under particular circumstances.

(2.) That distinguished experimenter found, that if radiant heat be intercepted by two transparent screens, the *additional* diminution of effect occasioned by the *second is proportionally much less* than that produced by the *first*; and the same conclusion is extended to any number of screens. This was explained by the supposition, that the heat in its passage through the first glass undergoes a certain modification, in some respects analogous to polarization, by which it is enabled to pass, with very little diminution, through the second and subsequent glasses.

(3) In those cases where the source of heat is luminous, such phænomena would receive an obvious explanation on the principle investigated in my former Paper. The simple radiant heat being stopped by the first glass, the second would produce an almost insensible diminution of the light, and therefore also of that species of heat which is transmitted in union with it.

But if the same effect is still observable below the point of luminosity, we must have recourse so some other principle of explanation. That deduced by DE LA ROCHE appears at least plausible; and though it should be considered proved, that in general heat is incapable of being radiated directly

through glass, it perhaps would not necessarily follow, that it might not, under peculiar circumstances, have a power of doing so communicated to it. Though on the other hand it must be confessed that, in the present case, some difficulty would attend such a supposition.

It certainly would not be easy to conceive such a property to be communicated to the heat by the mere act of being conducted through the first glass. Again; a new property of heat is thus introduced which, it must be conceded, is not absolutely and exclusively established.

It appeared to me therefore a point of some interest to examine, in the case of non-luminous heat—in the first place, the accuracy of the fact; and secondly, if verified, whether there might not be circumstances observable in the conditions of the experiment by which it might be accounted for, without the necessity of supposing any peculiar property of heat, or a direct transmission even through the second glass.

(4.) My apparatus in following up this enquiry was similar to that described by M. DE LA ROCHE, and consisted of two tin reflectors. In one focus the bulb of a thermometer coated with Indian ink, and in the other an iron ball two inches diameter, which was heated to redness, and then cooled till it ceased to be visibly red in the dark, at which point it was placed on its stand, and a thick screen withdrawn. The indications were observed, first for the direct effect; secondly, with one glass screen interposed; and thirdly, with two. In this way I tried various experiments; in some using only one reflector; in others both; in some employing a mercurial, in others an air thermometer. I conceive it unnecessary to bring forward all the various experiments I tried, and

shall content myself with giving a few of the most decisive, in a tabular form.

The first experiments I shall give, are two sets made with only one reflector, in the focus of which the bulb of a large differential thermometer was placed, and the progress of the effect traced for every 30 seconds successively in the three cases. The area of heating rays was limited by a circular aperture, about two inches diameter, in a pasteboard screen. The first screen, or that nearest the ball, was about $\frac{1}{12}$ inch in thickness, the second rather less. The divisions on the scale are arbitrary.

(5.)

One Reflector. Dist. 18 inches. No. I.				
Min.	Sec.	No Screen.	1 Screen.	2 Screens.
0	—	0	0	0
	30	5	0.5	0
1	—	9	1	0.25
	30	12	1.25	0.25
2	—	13.5	1.25	0.25
	30	14.5	1.5	0.25
3	—	15	1.5	0.25
	30	15.5	1.75	0.5
4	—	15.75	1.75	0.25
	30	16	1.75	0.5
5	—	15.75	1.75	0.5
	30	15.5	1.75	0,5
6	—	15	1.75	0.25
	30	14.25	1.5	0.5
*	*		*	*
8	30		1.5	*
9	—		1.25	*
11	—			0.25

One Reflector. Dist. 18 inches. No. II.				
Min.	Sec.	No Screen.	1 Screen.	2 Screens.
0	—	0	0	0
	30	5	1	0.5
1	—	9.5	1.5	1
	30	13	2	1
2	—	15	2	1
	30	16	2.25	1
3	—	16	2.5	1
	30	16.75	2.5	1
4	—	16	2.25	1.25
	30	15.75	2.25	1.25
5	—	15.5	2	1.25
	30	15	2	1.5
6	—	14.75	2	1.5
*	*			*
8	30			1.5
9	—			1.25
11	—			1.25
	30			1

(6.) In these experiments it appears that the effect with two screens is in a much greater ratio to that with one, than this to the direct effect. It is also obvious on inspection, that the

progress of the direct effect follows a different law from that with one screen, and this again from that with two; and in particular, that the maximum in the last case does not occur till considerably later than in the former. But if the effects were produced by a direct transmission, though their intensity would be diminished, they would follow a similar law; and the maximum would take place at the same time. These results then tend to show that the effect takes place by a secondary radiation. But from the inaccurate nature of the instrument, I place no reliance on these results alone.

(7.) To examine the point in a more complete and satisfactory manner, the two following sets of experiments were made with particular care, in which a mercurial thermometer was used, and the temperatures of the screens observed by means of a small thermometer attached to the face of each away from the ball, towards its central part: the bulb being kept in contact by the spring of a wire with which the thermometer was fastened. These thermometers were very nearly equal in size; the diameters of their bulbs being about 0.175 inch; that of the focal thermometer 0.55 inch, and detached about an inch from the mounting. It was graduated to quarters of centigrade degrees; the others only to whole degrees. Both the screens were of plate glass: the first or nearest the source of heat about $\frac{1}{12}$ inch in thickness; the second about $\frac{1}{8}$ inch.

(8.)

2 Reflectors, 15 inches distant. No. I.
1st. Screen $3\frac{1}{2}$ inches. 2d. 5 inches from ball.

		No Screen.	1 Screen.		2 Screens.		
Min.	Sec.	Focal Therm.	Focal Therm.	Temp. of Screen.	Focal Therm	Temp. of 1st Screen.	Temp. of 2d Screen.
0	—	16.75	16.75	17.5	16.5	18	17
	30	20	17	20	16.5	20	17
1	—	22.5	17.25	21	16.75	22	18
	30	24.5	17.5	24	17	24	18
2	—	25.75	17.75	26	17	25.5	18.5
	30	27	18.	27	17	28	18.5
3	—	28	18.	28.5	17	29.5	18.5
	30	29	18.25	29	17	30	18.5
4	—	29.25	18.25	30	17	31	18.5
	30	29.5	18.5	31	17	31.5	18.75
5	—	29.75	18.5	31	17	32	18.75
	30	30	18.5	31	17	32	18.75
6	—	30	18.5	31	17	32	19
	30	29.75	18.5	31	17	32	19
7	—	29.5	18.5	31	17	32	19
	30	29.5	18.5	31	17	32	19.5
8	—	29	18.5	31	17	31.5	19.5
	30		18.5	30.5	17	31	19.5
9	—		18.5	30	17	31	19.5
	30		18.25	30	17	31	19.5
10	—		18.25	30	17	30.5	19.5
	30		18.25	29.5	16.75	30	19.5
11	—		18.25	29	16.75	29.75	19.5
	30		18.25	29	16.75	29.5	19.5
12	—		18.25	28.5	16.75	29.	19.25
	30		18.25	28.5	16.75	28.75	19.25
13	—		18.25	28.5	16.75	28.5	19
	30		18	28	16.75	28.25	19
14	—		18	28	16.75	28	19

2 Reflectors, 12 inches distant. No. II.
1st Screen 2 in.—2nd $3\frac{1}{2}$ in. from ball.

		No Screen.	1 Screen.		2 Screens.		
Min.	Sec.	Focal Therm.	Focal Therm.	Temp. of Screen.	Focal Therm.	Temp. of 1st Screen.	Temp. of 2d Screen.
0	—	17	17	18	17	17	17
	30	21	17.25	20.5	17	19.5	17
1	—	24	17.75	25	17.25	25.5	17.5
	30	26	18	27	17.5	30	18
2	—	28	18.5	30	17.5	33	18.5
	30	29.5	18.75	32.5	17.5	35	18.5
3	—	30.5	19	34	17.5	37	19
	30	31	19.25	35	17.5	38	19.5
4	—	31.5	19.5	36	17.75	39.5	20
	30	31.5	19.75	37	17.75	40	20
5		31.5	19.75	37.5	17.75	40.5	20
	30	31.5	19.75	37.5	17.75	40.5	20.5
6	—	31.25	19.75	38	17.75	40.5	20.5
	30	31.25	19.75	38	17.75	40.5	21
7	—	31	19.75	38	17.75	40	21
	30		19.75	37.5	17.75	40	21
8	—		19.75	37.5	17.75	39	21
	30		19.75	37	18	39	21
9	—		19.75	36.5	18	38.5	21
	30		19.75	36	18	38	21
10	—		19.75	35.5	17.75	37.5	21
	30		19.75	35	17.75	37	21
11	—		19.5	35	17.75	37	21
	30		19.5	34.5	17.75	36.5	21
12	—		19.5	34	17.75	36	21
	30		19.5	33.5	17.75	35.5	21
13	—		19.25	33	17.75	35	21
	30		19.25	33	17.75	34.5	21
14	—		19.25	32.5	17.75	34	21
	30				17.75	33.5	21
15	—				17.75	3	21

(9.) From these results (with which all the others I obtained closely agree) I conceive it fully appears,—

1st. That the additional diminution occasioned by the second

screen is proportionally much smaller than that occasioned by the first. Thus De La Roche's conclusion is shown to hold good, not only in the case of luminous, but also of non-luminous hot bodies; which is perhaps of consequence, as I believe doubts have been entertained respecting it; and it may be remarked, that here the greater thickness of the second screen would be against such a result.

2dly. If the progress of the indications of the direct effect be followed, it appears that the rise in the first 30 seconds is the greatest, and those in the subsequent periods gradually diminish.

3dly. With one screen, the effect in the first period is equal to, or even less than those in the subsequent ones; and if we follow the temperature of the first screen, it appears to sustain a rapid increase at first, and afterwards continues gradually to rise till sometime after the focal thermometer has become stationary.

The progress of the focal thermometer exactly accords with what must be the heating effect of the screen as a source; viz. rising slowly at first as the screen acquires heat sufficient to supply it, and remaining stationary so long as the still increasing temperature of the screen could balance its loss of heat.

4thly. With two screens, there is no rise till the 2d half minute; when it is not greater than in the next half; after which the thermometer becomes stationary; and this trifling effect exactly accords with what the temperature of the second screen should produce. It does not begin till the second screen has acquired a higher temperature, and it is stationary while the temperature of the screen continues to

increase; and the temperature of the second screen is such as is clearly accounted for from the heating effect of the first. It does not begin to rise till after that of the first has risen: it continues stationary some time after the first has begun to cool, as the first screen did when the iron was cooling. But, as in this case, the source of heat was cooling during the whole time of the experiment, whilst in the other it was heating during the first part of the time, it follows, that a greater proportional temperature should be communicated to the second screen by the first, than to the first by the iron ball.

Other circumstances will partially co-operate in producing this effect; as the greater proximity of the second screen to the thermometer: also more heat might be lost in communicating an equable temperature to the first screen from its central and most heated part; whilst the heat would be thus more equally radiated to all parts of the second without such loss.

Thus it appears that the fact stated by M. DE LA ROCHE is fully substantiated; while on the other hand it is satisfactorily accounted for, without supposing any new property of heat, or any direct radiation through glass.

(10.) I have been more particularly led to this enquiry, from becoming acquainted with some experiments on the subject by Mr. RITCHIE, published in the Edinburgh Philosophical Journal, No. XXII. p. 281; in which, among other conclusions (to which I shall presently advert), he maintains, that at high temperatures below luminosity a portion of the heat radiates through glass of ordinary thickness, but without giving any details by which it can be made to appear that the effect is not sufficiently accounted for by secondary radiation. He has also given an explanation on his own

theory of the conclusion I have above examined, as deduced from De La Roche's experiments; but both that conclusion, and with it any such explanation, are now I conceive shown to be unnecessary.

(11.) The principal result obtained by Mr. Ritchie, and described in this Paper, is however of a nature deserving more attention. It exhibits an *exception* to the general law, in the instance of *glass of extreme thinness;* in which case the heat from a source below luminosity appears capable of radiating through such a screen when *transparent*, but not when rendered *opaque*.

As experiments conducted like those of Mr. Ritchie, with air thermometers, are always liable to uncertainty, I conceived it desirable to try the same thing with a mercurial thermometer.

(12.) I used as screens pieces of a large bulb blown to an extreme degree of tenuity; these were attached (as in Mr. Ritchie's experiments), to a circular aperture about $\frac{3}{4}$ inch diameter in a pasteboard screen. A second screen of milled board, with an aperture of 1 inch diameter, was placed about an inch from the first; and behind this the iron ball, previously cooled to just below visible redness. The same thermometer as in the preceding experiments was suspended at about $\frac{1}{2}$ inch from the screen. I made various trials, comparing the effect of the thin transparent screen with a similar opaque one: in some instances using three thicknesses of the glass, and afterwards the middle piece blackened on both sides with the soot of a candle; and in others two thicknesses, the inner surface of one being afterwards blackened; thus forming an opaque screen with the same vitreous surface. In all the experiments a thermometer suspended by the side

of the apparatus did not vary. The results of two sets of experiments are as follows:

Distance 6 inches.						No. I.
Min.	Sec.	3 Glasses.		Middle Glass blackened.		2 Glasses. 2d blackened.
		Exp. 1.	Exp. 2.	Exp. 1.	Exp. 2.	
0	—	17.25	17.25	17.25	17.25	17.25
	30	17.5	17.5	17.5	17.5	17.5
1	—	17.75	17,75	17.5	17.75	17.75
	30	17.75	17.75	17.75	17.75	17.75
2	—	18	17.75	17.75	17.75	18
	30	18	18	17.75	17.75	18
3	—	18	18	18	18	18

Distance 3 inches.					No. II.
Min.	Sec.	1 Glass.	2 Glasses.	2 Glasses. 2d blackened.	
				Exp. 1.	Exp. 2.
0	—	15.25	15.5	16	16
	30	16	16.25	16.5	16.75
1	—	16.5	16.5	16.75	17
	30	17	17	17.25	17.25
2	—	17.25	17.25	17.75	17.75

(13.) From these results, I think it will be admitted that no sensible difference appears in the two cases, sufficient to warrant any such conclusion as that alluded to. If the experiments described in this paper be regarded as sufficiently accurate, it follows upon the whole, that two principal exceptions to the general law, that simple heat cannot radiate through glass, are done away.

St. Helen's Place, March 9, 1826.

XXVII. *The Bakerian Lecture. On the relations of electrical and chemical changes. By Sir* HUMPHRY DAVY, *Bart. Pres. R. S.*

Read June 8, 1826.

I. *Introduction.*

A LONG time has elapsed since I read before this Society the Bakerian Lecture on the Chemical Agencies of Electricity. The general laws of decomposition developed in that Paper were immediately illustrated by some practical results, which the Society did me the honour to receive in a very favourable manner; and which, by offering a class of new and powerful agents, led me away for many years into a field of pure chemical enquiry: and it is only lately, and on an occasion which is well known, that I have again taken up the subject of the general principles of electro-chemical action. After a number of new experiments, which I shall have the pleasure of laying before the Society, and notwithstanding the various novel views which have been brought forward in this and in other countries, and the great activity and extension of science, it is peculiarly satisfactory to me to find that I have nothing to alter in the fundamental theory laid down in my original communication; and which, after a lapse of twenty years, has continued, as it was in the beginning, the guide and foundation of all my researches.

I am the more inclined to bring forward these new labours at the present moment, though they are far from being in a

finished state, because the discovery of OERSTED and that of MORICHINI, illustrated by some late ingenious enquiries, connect the electro-chemical changes with entirely new classes of facts, and induce a hope that many of the complicated phenomena of corpuscular changes, now obscure, will ultimately be found to depend upon the same causes, and to be governed by the same laws; and that the simplicity of our scientific arrangements will increase with every advance in the true knowledge of nature.

II. *Some historical details.*

As I am not acquainted with any work in which full and accurate statements on the origin and progress of electro-chemical science are to be found, and as some very erroneous statements have been published abroad, and repeated in this country, I shall take the liberty of laying before the Society a short historical sketch on this subject; which is the more wanted, as the journal in which the early discoveries were registered has long been discontinued, and is now little known or referred to.

As there are historians of chemistry and astronomy who date the origin of these sciences from antediluvian times, so there are not wanting persons who imagine the origin of electro-chemical science before the discovery of the pile of VOLTA; and RITTER and WINTERL have been quoted* amongst other persons as having imagined, or anticipated the relation between electrical powers and chemical affinities, before the period of this great invention. But whoever will read with attention RITTER's "Evidence that the galvanic

* OERSTED, translated by MARCEL, 1813.

action exists in organized Nature,"* and WINTERL's "Prolusiones ad Chemiam Sæculi decimi noni," will find nothing to justify this opinion. RITTER's work contains some very ingenious and original experiments on the formation and powers of single galvanic circles; and WINTERL's some bold, though loose speculative views† upon the primary causes of chemical phenomena: and in the obscurity of the language and metaphysics of both these Gentlemen, it is difficult to say what may not be found. In the ingenious, though wild views, and often inexact experiments of RITTER, there are more hints which may be considered as applying to electro-magnetism than to electro-chemistry; and WINTERL's miraculous "*Andronia*" might, with as much propriety, be considered as a type of all the chemical substances that have been since discovered, as his view of the antagonist powers, the acid and basic, can be regarded as an anticipation of the electro-chemical theory. The queries of NEWTON at the end of his "Optics" contain more grand and speculative views that might be brought to bear upon this question than any found in the works of modern electricians;‡ but it is very unjust to the experimentalists

* Jena, 1800.

† As a specimen of the Prolusiones, I shall give a few articles from the Index, which will show the character of the work. Prolusiones, pag. 256, et seq.

256. "Adamas est Andronia.

260. "Andronia cum Plumbo creat Barytam, cum Ferro Chalybem.

262. "Carbo est acidus cum Atmosphæra basica.

263. "Chromium non est nisi Calx Magnesii acida.

——. "Cuprum cum Androniâ coalescit in Molybdænum.

268. "Scintilla electrica formatur à Principiis Conductorem primum et secundum animantibus, ac inter se concurrentibus; est gravis, habet effectum electricitati contrarium."

‡ See the eloquent observations of Mr. CHENEVIX on the subject of WINTERL's Theory, Annales de Chim. Vol. 50, 2 Cap. 175.

who, by the laborious application of new instruments, have idscovered novel facts and analogies, to refer them to any such suppositions as, " that all attractions, chemical,* electrical, magnetic, and gravitative, may depend upon the same cause;" or to still looser expressions, in which different words are used and applied to the same ideas, and in which all the phenomena of nature are supposed to depend on the Dynamic system, or the equilibrium and opposition of antagonist powers.

The true origin of all that has been done in electro-chemical science was the accidental discovery of MM. NICHOLSON and CARLISLE, of the decomposition of water by the pile of VOLTA, April 30, 1800.† These Gentlemen immediately added to this capital fact, the knowledge of the decomposition of certain metallic solutions, and the circumstance of the separation of alkali on the negative plates of the apparatus. Mr. CRUICKSHANK, in pursuing their experiments, added to them many important new results, such as the decompositions of muriates of magnesia, soda and ammonia, by the

* In the Systême Universelle of M. AZAIS, not only are all the phenomena of nature referred to the same cause, but specific reasonings upon the mode of its operation given. In this work, published in 1810, not only is the identity of Magnetism and Electricity insisted on, but an attempt is made to explain the manner in which the two electrical fluids produce the magnetic phenomena, pag. 239 Vol. I. " Ainsi ces deux ordres de phénomènes sont tres ressemblans. Repetons que toutes leurs différences résultent uniquement de ce que les deux fluides sont moins intenses lorsq' ils produisent les phénomènes du Magnétisme que lorsq' ils produisent les phénomènes du Galvanisme, &c." It requires only the same principle as that censured in the text to refer to this author the discovery of OERSTED and the speculations of AMPÈRE. M. AZAIS, in his " fluides mineure et majeure," finds all the causes of the acid and alkaline properties of bodies:—slow combinations, the heat produced, and all the phenomena of chemical change; and his reasonings are often very ingenious.

† NICHOLSON'S Journal, Vol. 42, page 183.

pile; and that alkaline matter always appeared at the negative, and acid at the positive pole:* and Dr. HENRY about the same time made some unsuccessful attempts to decompose potassa in solution by the pile, and confirmed the general conclusions of MM. NICHOLSON, CARLISLE and CRUICKSHANK. In the month of September in this year, I published my first Paper on the subject of Galvanic Electricity, in NICHOLSON's Journal, which was followed by six others:† the last of which appeared in January, 1801. In these Papers I showed that oxygen and hydrogen were evolved from separate portions of water, though vegetable and even animal substances intervened; and conceiving that all decompositions might be polar,‡ I electrised different compounds at the different extremities, and found that sulphur and metallic substances appeared at the negative pole, and oxygen and azote at the positive pole, though the bodies furnishing them were separate from each other. In the same series of papers I established the intimate connexion between the electrical effects and the chemical changes going on in the pile, and drew the conclusion of the dependence of one upon the other. In 1802 I proved that galvanic combinations might be formed from single metals, or charcoal and different fluids chiefly acid and alkaline, and that the side or pole of the conducting substance in contact with the alkali was positive, and that in contact with the acid, negative; and in the same year I published, that when two separate portions of water, connected by moist bladder or muscular fibre, were electrised, nitro-muriatic acid appeared at the positive, and fixed alkali at the negative pole.‡ In the same year Dr. WOLLASTON placed

* NICHOLSON's Journal, Vol. IV. p. 190. † Ibid, pp. 275, 326, 337, 394, 380.

‡ Journal of the Royal Institution, 1802, First Series.

the identity of the cause of galvanism and electricity, which had been always maintained by VOLTA, out of all doubt, by some very decisive experiments.

In 1804, MM. HISINGER and BERZELIUS stated that neutro-saline solutions were decomposed by electricity, and the acid matter separated at the positive, and the alkaline matter at the negative poles; and they asserted that in this way muriate of lime might be decomposed; and drew the conclusion that nascent hydrogen was not, as had been generally believed, the cause of the appearance of metals from metallic solutions. These valuable observations ought to have explained distinctly the source of the appearance of acid and alkaline substances at the two extremities of the pile, yet the Paper was never translated into English, nor at all attended to; and one of their facts was contradicted by the assertion of, generally, a very accurate observer, Mr. CRUICKSHANK, who in his early experiments mentioned that he had not been able to decompose muriate of lime in the circuit.

In 1805 various statements were made, both in Italy and England, respecting the generation of muriatic acid and fixed alkali from pure water. The fact was asserted by MM. PACCHIONI and PEELE, and denied by Dr. WOLLASTON, M. BIOT, and the Galvanic Society at Paris.* Mr. SYLVESTER, who

* Some writers have very incorrectly referred the origin of these researches to the observations of HISINGER and BERZELIUS; Annales de Chem. Vol. 51. 1 Cap. pag. 167; but these observations were never quoted by any writer of the day on the pretended production of muriatic acid and alkali; and I was not acquainted with them till after my fundamental experiments were finished; and, when in drawing up an account of them, I looked back through the whole series of periodical publications to find accounts of experiments bearing upon the same question, and I believe I first directed the public attention to the value of those researches.

conducted his experiments with some care, stated, that if two separate portions of water were electrised out of the contact of substances containing alkaline or acid matter, acid and alkali were generated; so that up to this time the question, whether these substances were liberated from their combinations, or formed from their elements by electricity, could not be considered as decided: a circumstance not so much to be wondered at, when the novel and extraordinary nature of the whole class of galvanic phenomena is considered.

It was in the beginning of 1806* that I attempted the solution of this question; and after some months' labour I presented to the Society the Dissertation, to which I have referred in the beginning of this Lecture. Finding that acid and alkaline substances, even when existing in the most solid combinations, or in the smallest proportion in the hardest bodies, were elicited by Voltaic electricity, I established that they were the results of decomposition, and not of composition or generation; and referring to my experiments of 1800, and 1801 and 1802, and to a number of new facts, which showed that inflammable substances and oxygen, alkalies and acids, and oxidable and noble metals, were in electrical relations of positive and negative, I drew the conclusion, *that the combinations and decompositions by electricity were referrable to the law of electrical attractions and repulsions*, and advanced the hypothesis, "*that chemical and electrical attraction were produced by the same cause, acting in one case on particles, in the other on masses;*" *and that the same property, under*

Whoever will take the trouble to read the Bakerian Lecture for 1806, will be convinced of the gradual developement of the whole subject from the investigation respecting the pretended formation of muriatic acid and fixed alkali.

* Phil. Trans. 1807.

different modifications, was the cause of all the phenomena exhibited by different Voltaic combinations.

Believing that our philosophical systems are exceedingly imperfect, I never attached much importance to this hypothesis; but having formed it after a copious induction of facts, and having gained immediately by the application of it a number of practical results, and considering myself as much the author of it as I was of the decomposition of the alkalies, and having developed it in an elementary work, as far as the present state of chemistry seemed to allow, I have never criticised or examined the manner in which different authors have adopted or explained it,—contented, if in the hands of others it assisted the arrangements of chemistry or mineralogy, or became an instrument of discovery. And having now given what I believe to be a faithful sketch of its origin, I shall not enter into an examination of those works which have induced me to make this sketch, and which contain partial or loose statements on the subject, and which refer the origin of electro-chemistry to Germany, Sweden and France, rather than to Italy and England and which attribute some of the views of the science, which I first developed, to philosophers who have never made any claim of the kind, and who never could have made any, as their works on the subject were published many years after 1806.

III. *On the modes adopted for detecting the electrical states of bodies, and definitions of terms.*

That the statements made in the following sections may be more distinct, I shall say a few words of the mode in which the different conditions of electrical action were ascer-

tained, and describe the manner in which I have used the terms which have been adopted in electro-chemical science.

In determining the nature of the electrical action in what may be called the closed circle, or the combinations in which, according to the language used on the Continent, electrical currents exist, I have employed instruments constructed upon the same principles as the galvanometer of Professor CUMMING, or the multiplier of Professor SCHWEIGGER. Silver wire, covered with silk, about $\frac{1}{70}$ of an inch in diameter, was folded round a small wooden frame, so as to fill a narrow deep groove: the two extreme wires were parallel, and the convolutions as nearly as possible in the same perpendicular: a small tube containing a filament of silk was passed through the centre of the convolutions of wires, to which a delicate magnetised needle was suspended; which, when the apparatus was properly disposed, rested with its north pole between the two extremities of the wires. This instrument, which contained 60 circumvolutions of wire, was found sufficiently delicate for most purposes of experiment; but in a few instances, in which very weak electricities were to be determined, I used another apparatus, in which the same kind of wire was fastened, in concentric circles, round two portions of glass tube, in such a manner that radii from the inner circle would have passed through all the wires, and in which increased mobility was given to the system by two needles exterior to it and connected with it, placed one above, the other below the central needle, with their poles in the same directions, but opposite to those of the central needle, which was so magnetised that its directive power was neutralised by the power of the other two needles.*

* This arrangement differs from that of M. NOBILE only by a duplication of effect.

To illustrate the operation of these apparatus, I shall state, that when the lower terminating wire, which was to the left, or east of the north pole, was connected with a piece of zinc, and the upper one with a piece of platinum, both being in common water, the deviation of the central needle was eight or ten degrees, the south pole turning to the east or left hand; which may be considered as indicating that the current of electricity was from the platinum to the zinc through the wire, and that the surface of the zinc in the fluid was positive with respect to the opposite surface of platinum; and in using the terms positive and negative, I beg to be understood as applying them to the metallic surfaces in contact with the fluid.

For determining weak electricities of charge, or as it is sometimes called, of tension, I used VOLTA's condenser connected with BENNET's electrometer, and sometimes with one constructed on the principle of BEHRENS, consisting of an insulated gold leaf, or what I found better, a silk filament, made conducting by impalpable charcoal powder, to receive the charge, placed between the poles of a dry pile consisting of 400 circles of silver and gold foil, of the third of an inch in diameter, or 50 of zinc and silver of the same size, with paper intervening; the attraction of the gold leaf or the filament, either to the positive or negative pole, indicates the nature of the charge: and, as in cases of electro-chemical action there are always two corresponding opposite states, I considered the part of the system which touched the conductor as possessing the same electrical state with that exhibited by the leaf. I have never however put much dependence upon indications given by this instrument, unless they were confirmed by other results; having found them very uncer-

tain and influenced by the state of the condenser and the atmosphere.

IV. *On the electrical and chemical effects exhibited by combinations containing single metals and one fluid.*

I know of no class of phenomena more calculated to give just views of the nature of electro-chemical action than those presented by single metals and fluids; and as their results are, with one or two exceptions, entirely new, I shall describe them with some degree of minuteness. When two pieces of the same polished copper, connected with the platinum wires of the multiplier, were introduced at the same time into the same solution of hydro-sulphuret of potassa, there was no action; but if they were introduced in succession, there was a distinct and often, if the interval of time was considerable, a violent electrical effect—the piece of metal first plunged in being negative, and the other positive.

This result depends upon the circumstance of the production of a new combination, which is negative with respect to the metal; for after the formation of the sulphuret of copper, the plate of copper that has been first plunged into the solution exhibits the same negative state with respect to polished copper, whether introduced into saline solutions, or alkaline or acid menstrua. The electrical effect therefore does not depend on so simple a condition as would at first appear, and it may be in fact referred to the combinations containing two metallic substances and one fluid.

The grey sulphuret of copper is negative, in solutions of hydro-sulphuret, to clean copper, and the superficial coating has apparently similar electrical powers to this substance.

Copper, in the state of protoxide, is negative, not only with respect to metallic copper, but likewise with respect to the sulphuret; a circumstance which explains many singular and apparently anomalous circumstances with respect to the action of hydro-sulphuret on copper. I have often found the order which I have mentioned, of metallic copper being positive with respect to copper that had been a few seconds in solution of hydro-sulphuret, reversed in a singular and capricious way; but on investigating the cause, I found that the copper was tarnished; and on heating any kind of polished copper strongly, so as to produce a thin coating of oxide any where on its surface, it became strongly negative to copper plunged in solution of hydro-sulphuret: the same effect was produced by the action of acids.

There are some singular circumstances connected with the violent and intense chemical action of copper on solutions of hydro-sulphurets, which are worthy of being described. When a piece of copper connected with the multiplier has been for a minute in strong solution of hydro-sulphuret of potassa, on introducing a piece of polished copper connected with the other wire, there is often a violent and momentary negative charge communicated to it, which sends the needle through a whole revolution: it then oscillates, and almost immediately returns, and takes the direction which indicates that the piece first plunged in is negative. This effect continues for some minutes, then becomes weaker; at last the two sides are in equilibrium, and the piece which was first plunged in now becomes positive with respect to the other. The first described of these effects seems to depend upon the discharge, by the clean copper, of the negative electricity accumulated

by the contact of the plate first plunged in, before the relative states produced by the metallic contact and the regular currents occur; and the second, to the detaching or peeling off of the coat of sulphuret, which has the effect of exposing a clean surface, and which effect is probably occasioned by the oxidation of the positive side of the plate.

There are few electrical actions more intense than those produced by the operation of hydro-sulphurets on copper in these different circumstances; so much so, that I have constructed a Voltaic battery which decomposed water, by six combinations, consisting merely of thin slips of copper, of which one half had been exposed to the solution about a minute before the other half: of course, the oxidating surface was on the side of the clean or latest exposed metal.

With lead, and alloys of tin and lead and iron, there are the same phenomena, but much feebler electrical action, the metallic surface which is first introduced being the negative surface; and the principles of this kind of action are precisely the same as those of copper and hydro-sulphurets.

Zinc, platinum, and metals which have no chemical action on solutions of hydro-sulphurets, produce no phenomena of this kind; silver and palladium, which act powerfully with these menstrua, produce very decided effects; but the compounds they form in them being positive with respect to the pure metals, the phenomena are the reverse of those offered by the more oxidable metals: the surface plunged first into the solution is the positive surface, and it retains this relation in alkaline, acid, and saline solutions, presenting peculiarities dependent upon the change of surface, which I shall refer to again hereafter.

The production of electrical currents by single metals and single fluids, though most distinct in the cases I have just named, yet occurs generally whenever new substances which can adhere to the metals are produced in chemical action. Thus in acid solutions of a certain strength pieces of the same zinc, tin, iron, and copper, exhibit similar phenomena; the surface first plunged into the acid being tarnished, or retaining a slight coat of oxide, is negative to the metal plunged in afterwards, and the relation is sustained in saline or alkaline solutions. The same effect is caused by producing a coat of oxide by heat on the surface, or even by applying it artificially. The oxidated surface is negative with respect to the other.

Zinc, which dissolves in a strong solution of potassa, giving off hydrogen copiously, exhibits exactly the same phenomena in this solution; the tarnished metal, or that first introduced, being negative with respect to the other. Tin likewise in solution of potassa, having been introduced long enough to have tarnished, is strongly negative with respect to polished tin.

Even the noble metals obey the same law. Silver, that has been tarnished by the action of nitric acid, is negative to polished silver in diluted acid; and gold and platinum, that have been acted on by aqua regia, are negative in that acid to the clean metals.

The intimate connexion displayed in all these cases between the chemical and electrical phenomena, becomes still more remarkable when the nature of the changes taking places in circles of this kind is considered.

Oxygen, which may be considered as negative with respect

to all the metals, and sulphur, which is negative with respect to the oxidable metals, by their combinations with metals respectively positive to them, produce compounds negative with regard to those metals. And in the chemical changes, the results are such as must ultimately restore the equilibrium, hydrogen or sulphuretted hydrogen passing to the negative side, and oxygen to the positive side; so that the oxides are revived; and not only is the equilibrium restored, but the poles sometimes changed. Thus tin that has tarnished in acid, remains for some time negative in solution of alkali, but gradually as the oxide upon it is revived by the hydrogen determined to this surface, it loses its negative power; and the other surface, now tarnished by the action of the alkali, gains this power, whilst the opposite surface becomes positive.

V. *Of electrical combinations, consisting of two imperfect, and one perfect conductor; or two fluids and a metal, or charcoal.*

To understand clearly the nature of the action in this kind of electrical combination, it is necessary to consider the nature of imperfect conducting bodies, water, or saline solutions. These bodies may be regarded as having the same relations to electricities of very low intensity, that elastic fluids have to the electricities of glass, sealing wax, or the common machine. They communicate the electrical polarities of the metals, but do not appear capable of receiving such polarities, or at least of retaining them; and the electrical equilibrium, when broken in them, seems to be rapidly restored by a new arrangement or attraction of certain of their

elements. For instance, if we introduce the positive and negative poles from a very powerful Voltaic battery into the extremities of a basin filled with solution of muriate of lime, and place in the circuit different wires of platinum, every wire will possess a positive and negative pole, and there will be no division of the fluid into two parts, one positive, the other negative; and when the two wires are withdrawn, they alone having been used, the electrical appearances immediately cease; and metallic wires unconnected with the battery made to occupy their places, exhibit no electrical phenomena: and in all experiments of this kind, the well known phenomena of the developement of chlorine and oxygen and acid matter at the positive, and hydrogen, alkaline matter, &c. at the negative pole, takes place.

Acid and alkaline matters, when perfectly dry and non-conducting, become on contact negative and positive; as I have shown is the case with oxalic acid and lime; but this effect is similar to that of glass and silk, and the results is a common electricity of tension. And when acids and alkalies combine, their union being apparently the result of the same attractive powers acting on the particles which would produce their electrical relations as masses, they exhibit no phenomena of electro-motion; and such phenomena, when they occur in combinations in which acids and alkalies unite, always depend upon the contact of the metal with the acid and alkaline matter, change of temperature, evaporation, &c. and never on the combination of the acid and alkali.

As a different opinion has been lately started, on high authority,* I shall give the proofs of the truth of this my

* That of M. BECQUEREL.

early view, which appear to me of the strictest demonstrative nature.

A solution of nitre, which is a substance neutral to the contact of noble metals, was introduced into a glass cup containing a plate of platinum connected with the multiplier; pure concentrated nitric acid was placed in another cup, in which there was another plate of platinum joined to the other wire of the multiplier, and the connexion was made by a piece of asbestus wetted in a solution of nitre. At the moment of contact, the needle indicated a strong electrical action, negative on the plate plunged in the acid, and which occasioned a permanent deviation of about 60°.

This arrangement was removed from the multiplier, and another substituted for it, in which strong solution of potassa occupied the place of the nitric acid, being in contact with platinum in one cup, and solution of nitre in the other, with the same communications. The deviation was now much weaker, about 10 degrees, and the platinum in the solution of potassa was positive.

The nitric acid and the solution of potassa were now connected in the arrangement by a piece of clean asbestus, moistened in a concentrated solution of nitre; the deviation of the needle was to about 65°. In this instance there was no chemical action of the fluids on each other; for they had no tendency to mix rapidly with the solution of nitre, which being of less specific gravity than either of the other solutions, remained in the asbestus; and there was no effect beyond that of the metallic contact of the platinum with acid and alkali.

A piece of asbestus, of nearly the same size with the other,

but dry, was now substituted for the moist asbestus, so that the acid and alkali combined by capillary attraction producing heat; at first, the deviation was rather less than in the former instance; but as soon as the combination was complete, the needle stood exactly at the same point, proving that no electricity was developed by the combination, any more than by the indirect communication of the acid and the alkali.

After trying the effects of the contact of fluid acid upon platinum by the arrangement with solution of nitre, and finding that oxalic acid was the acid among the powerful ones which produced the slightest deviation of the needle, or the smallest negative effect, I employed this acid and solution of potassa, exactly in the same manner as the nitric acid in the experiment just detailed; as the joint action of the acid and alkali on the platinum was only to produce a deviation of 7 or 8 degrees, it might be suspected that any electrical action produced by combination might be more easily manifested; but no such effect occurred; and whether the communication was made by combination through dry asbestus, or through asbestus wetted in a saline solution, the effect was precisely the same.

Again,—the two surfaces of platinum were placed in contact with strong solutions of nitre, and the communication made between them by solution of potassa and nitric acid; there was no electrical action though the chemical combination was intense. But when the fluids were mixed, so that a little acid touched one plate of platinum and a little alkali the other, electro-motion immediately began; and in using muriatic acid and solution of ammonia, which, being lighter

than the saline solutions, very soon came in contact with the platinum, the effect commenced almost immediately, and continued for some time to increase.

Again,—I placed pieces of paper coloured with litmus and turmeric, and moistened in solutions of nitre, upon two surfaces of platinum connected with the multiplier; they were covered with a stratum of porcelain clay wetted with the same solution, a stratum of clay moistened with muriatic acid was placed above on one plate, and a stratum moistened with solution of ammonia above on the other, so as to make a contact in which there should be action upon a large surface without direct communication with the metals. In several experiments of this kind there was no electro-motion; and whenever it was perceived it was found that either the acid, or the alkali, or both, had penetrated through the clay, and touched the metals so as to change considerably the colour of the papers, which were placed as indications of the correctness of the experiment.

Having brought forward what appear to me decided proofs on this subject, I shall now proceed to investigate the operation of the metals and fluids in combinations containing two of the latter substances. At first I was surprised to find that platinum acted so powerfully with nitric acid, which undergoes no chemical change by contact with it, and suspecting that it might arise from the presence of minute portions of muriatic acid or muriatic salts, I took great pains to exclude these substances by washing the platinum in distilled water, not touching it with thc hands, &c. but when the conditions were those of perfectly clean and pure platinum and perfectly pure nitric acid, the phenomena were the same. Similar

reasonings may be applied to solutions of potassa, soda, &c. which do not chemically alter platinum by contact, and yet render it positively electrical with respect to platinum in water or saline solutions. It must however be called to mind that the oxygen in nitric acid, and the metals in the alkalies, have attractions of a very decided kind for platinum; and in taking the scale of electro-negative bodies, solutions of chlorine, or nitro-muriatic acid, produce a more powerful electrical effect on platinum than nitric acid, nitric acid than muriatic, and muriatic than sulphuric.

When platinum is brought in contact with an acid, the pole touching the acid is negative, the opposite pole is positive, as I have found by the condensing electrometer; and the reverse is the case when it touches an alkali, so that the circulation of the electricity is from the metal to the alkali, and from the acid to the metal.

Rhodium, iridium, and gold, act in combinations consisting of acid and alkali, on which they have no chemical effect, exactly like platinum; the surface of the metal in the solution of alkali being positive, that in the solution of the acid, negative. With silver and palladium the electricity is greater, particularly if nitric acid is used; and with charcoal and oxidable metals, there is the same general result, the action being in general exalted in proportion as the chemical attractions are stronger, provided there are no interfering circumstances: and in combinations of this kind nitro-muriatic acid is more active than nitric, and the order is after, nitric, nitrous sulphuric, phosphoric, vegetable acids, sulphurous, prussic, sulphuretted hydrogen, and, with the alkalies, potassa, soda, baryta, ammonia, and so on.

It is always to be understood that strong or concentrated solutions of acids and alkalies are employed; for in cases where the quantity of acid or alkaline matter is very small and the chemical action of the metals strong, there is sometimes a different order. Thus zinc and tin tarnish immediately even in a weak solution of potassa, and, so tarnished, they are negative to the same metals in weak solutions of muriatic or sulphuric acid; but in experiments of this kind it is easy to determine the true circumstances by changing the poles; the negative side, when the energies of the alkali and acid are weak will be determined by the tarnish or coat of oxide formed.

Solutions of sulphurets act in these combinations like alkali, with circumstances depending upon the formation of new compounds according to the law explained in the last section. In combinations, of which the elements are hydro-sulphuret and acid, the metal in the hydro-sulphuretted solution is positive, and that in the acid negative; but with alkalies and hydro-sulphurets, and zinc and tin, the metal in the solution of alkali is positive, and that in the solution of hydro-sulphuret negative: with silver and palladium the opposite order occurs, and with copper there is nearly a balance of powers, or changes of power, dependent upon the circumstances detailed in the last section.

When, in electrical combinations containing one metal, water, or a neutro-saline solution is in one of the cups and alkali or acid in another, the result is usually such as might be anticipated,—the side of the metal in the alkali is positive, that in the acid negative, and that in the neutro-saline solution in the opposite state. There are however certain neutro-

saline solutions, which when they contain oxygen or common air, act upon the more oxidable metals, and such have a power or energy of their own ; thus zinc, and tin, and copper in solution of common salt, are positive to the same metals in distilled water; and the surfaces of the same metals in weak muriatic acid are positive with respect to the surfaces in water or saline solutions. In combinations, in which weak and strong solutions of acids or of alkalies are the two fluids, both being of the same kind, the electrical action is usually feeble ; but the surface in the strongest alkali is most positive, and in the acids the result usually depends upon the nature of the solution ; if oxide is formed and deposited, the strongest acid is negative with respect to the diluted one.

The chemical changes produced in combinations of this kind, are best observed in cases where the metals undergo no change; for instance, with platinum, diluted sulphuric acid, and solution of potassa. In this combination, hydrogen soon appears on the platinum in the acid, and a very small quantity of gas, which is probably oxygen, on the platinum in contact with the alkali ; and that the acid tends to circulate towards the negative surface, and the alkali towards the positive, is shown by the circumstance of the rapid neutralization of the two menstrua, though separated by asbestus moistened in distilled water.

VI. *Of combinations consisting of two conductors of the more perfect class, and one fluid.*

The order in which metallic bodies exhibit electricities on contact, as is well known, is intimately connected with their relative oxidability, the most oxidable metal being positive

with respect to all those below it. This law extends likewise to the newly discovered bases of the alkalies and earths. Potassium and sodium, as I have found by bringing them in contact with zinc in a concentrated solution of alkali, are apparently as much positive with respect to this body, as zinc is with respect to platinum and gold.

There is not however any inherent and specific property in each metal which gives it the electrical character; it depends upon its peculiar state—on that form of aggregation which fits it for chemical change. Thus, zinc in amalgamation with mercury is positive with respect to pure zinc, and the amalgam of tin is in the same state with regard to tin; and the metals of the fixed alkalies in amalgam give the highest positive energy to a mass of mercury some thousands of times their weight.

In general, the electricities developed by metallic contact are of a stronger kind than those resulting from the contact of metals with fluids, so that they are not capable of being changed by them. For instance: zinc in acid is positive with respect to all other metals below it in degree of oxidability, though they are placed in alkalies or solutions of sulphurets: there are however exceptions; for instance, with regard to tin, which, when in a strong solution of potassa is positive to zinc in an acid solution; and with respect to iron, which, though positive with regard to copper in all acid or neutro-saline fluids, is negative to it in solution of sulphurets or of alkalies. The electro-motion in these instances produced by the contact of the fluids prevailing over that produced by the contact of the metals.

And knowing the energies of the acid and alkaline fluids, it is easy to apply them so as to diminish or enhance the electrical effects developed by metallic contact.

If, for instance, in a combination containing zinc and platinum, we use two fluids, and place the acid in contact with the zinc, and the alkali with the platinum, the effect will be exceedingly feeble compared with that produced if the order be reversed, and the zinc be in contact with the alkali, and the platinum with the acid.

The chemical changes taking place in combinations of this kind are always such as tend to restore the equilibrium, the hydrogen and the alkaline body always passing to the negative, and oxygen and the acid to the positive metal.

There is no instance of continued electro-motion except in cases where chemical changes can take place, for even DE LUC'S or ZAMBONI'S columns do not act when quite dry, and the silver in combinations of this kind, when the negative metal is gold, is uniformly found tarnished: for the exhibition of electricities of tension, however, a very slight chemical action is sufficient, as the quantity of electricity required to give repulsion to light bodies is exceedingly small; but to form electro-magnetic combinations the chemical agents must be of an energetic kind.

As most of the fluids which act powerfully in voltaic combinations containing water, or oxygen and hydrogen, it has been suspected that these principles were essential to the effect; this however does not seem to be the case, for I found zinc and platinum formed powerful electro-motive circles in fused litharge and fused oxy-chlorate of potassa, which are not

known to contain water; and I have little doubt that similar effects would be produced by other fused salts containing only acid and alkaline matter.

It may elucidate this part of the subject, which must at best be obscure, to take a view of the changes occurring in one of the simplest voltaic combinations, that consisting of zinc, platinum, and solution of sulphate of soda. It is a fact that zinc and platinum become electrical by contact, the zinc positive, the platinum negative; and the two kinds of electricity are apparently most intense at the surfaces where they are in contact with the fluid, which is too imperfect a conductor to allow them to neutralize or destroy each other: they consequently exert their attractive and repellent powers upon the elements of the menstruum; acid and oxygen circulate to the surface of zinc, which in consequence is dissolved, and alkali and hydrogen to the surface of platinum, of which the hydrogen is disengaged, and the equilibrium broken by the contact of the metals is restored by the chemical changes; so that a constant circulation, or a current of electricity, takes place, the power of the combination becoming feebler in proportion as the solution is decomposed, and acid accumulated round its positive, and alkali round its negative surface.

In cases where acids or acid solutions alone are used, the destruction of one or both surfaces, with the tranfer of hydrogen or oxygen, seems to produce the same effect; and the inactivity of single circles or Voltaic piles, in which pure water is used or saline solutions freed from air, seems to show that the destruction of the surface of the oxidable

metal is one of the conditions of continued electrical action; and the cessation of the power of DE LUC's or ZAMBONI's piles, is always connected with the tarnish of the imperfect metal employed in them.

Having published many years ago tables of the electro-chemical relations of metals, which have been copied into many elementary books, I think it proper to give them here in a corrected form with some additions, and the differences dependent upon the nature of the menstruum. The metal mentioned first is positive to all those below it in the scale.

With common acids.

Potassium and its amalgams; barium and its amalgams; amalgam of zinc; zinc; amalgam of ammonium (?); cadmium, tin, iron, bismuth, antimony (?), lead, copper, silver, palladium, tellurium, gold, charcoal, platinum, iridium, rhodium.

With alkaline solutions.

The alkaline metals and their amalgams: zinc, tin, lead, copper, iron, silver, palladium, gold, platinum, &c.

With solutions of hydro-sulphurets.

Zinc, tin, copper, iron, bismuth, silver, platinum, palladium, gold, charcoal.

VII. *On the accumulation of electricity, and the chemical changes it occasions in Voltaic arrangements.*

In the view of electro-motion adopted by the illustrious inventor of the pile, the metals were considered as the *only*

agents which, in proportion to their surface and their number, occasioned the constant circulation of a certain quantity of electricity through the fluids, or the connecting wires in the pile; and the chemical changes occurring in these fluids were considered as mere results, and not necessarily connected with the circulation. The inactivity of combinations where no chemical changes occur, is sufficiently hostile to this view; but an examination of some of the circumstances of the construction of compound electrical combinations, will bring this hypothesis, and that which I have ventured to adopt, more distinctly into comparison.

Let a piece of zinc and a piece of platinum, both in glasses filled with a solution of nitrate of potassa, be connected through the multiplier, and let the glasses be joined by asbestus moistened with the same fluid; the needle will mark electrical action: let the two glasses now be joined by an arc composed of zinc and platinum, in such a manner that the order is Voltaic, i. e. that the zinc is opposite to the platinum, in the original combination—the effect will be increased. Now let an arc of pure zinc be introduced; the effect will be less than with the double arc, but superior to that with the asbestus, and the pole of the zinc opposite the platinum will oxidate, and that opposite the zinc will give off hydrogen. Let arcs of other metals be substituted for the zinc; for instance, of tin, of iron, of copper, of silver, of tellurium: the electrical effects will diminish with the oxidability of the metal; and with tellurium, which does not oxidate at the positive pole of a Voltaic battery, they will be destroyed; and the case is the same with rhodium, palladium and pla-

tinum. That the effect does not depend upon any circumstance connected with conducting power is evident; for charcoal, which is a very imperfect conductor, acts like an oxidable metal; and a very fine wire of platinum, terminated by a small piece of oxidable metal, acts more efficiently when the oxidable metal is opposite the negative pole, than if the whole chain had been composed of oxidable metal; but entirely destroys the effect when the oxidable metal is opposite the positive pole.

If the contact of the metals only was necessary for continued electro-motion, these results, in which a simple homogeneous chain is interposed between the fluids, would be impossible; but they are a necessary consequence of the electro-chemical theory, in which the destruction of the positive surface by the chemical negative agent is regarded as a necessary condition; and platinum and tellurium acted like zinc, when their surfaces opposite to the platinum were plunged into diluted nitro-muriatic acid.

If two, three, or four glasses are used, and two, three, or four arcs of platinum and zinc, the extreme metals of which are connected through the multiplier, a piece of platinum used instead of one of the arcs will not now entirely destroy the electro-motive effect: it will be diminished as if one arc had been removed. The two will act as a single combination; the three as two arcs, and the four as three; and of course in a Voltaic combination of 100 arcs, a single piece of platinum substituted for any one of the arcs, will diminish the power of the apparatus only $\frac{1}{100}$ part.

In attempting to protect copper by zinc, in a separate

vessel, from the action of sea water, I found that when the two vessels were connected by moist tow or vegetable substances, or by a wire (even though fine) of any oxidable metal, the protection was complete: but when even a thick wire of platinum was employed, the copper, though in immediate contact with the zinc, became corroded. After the experiment had continued several days, the surface of the platinum opposite to the copper was found tarnished, as if it had been slightly acted upon by the chlorine combined in the sea water; but this effect had been too feeble to be connected with any sensible degree of electrical polarity in the platinum.

This result, with those mentioned in the preceding pages, seems to show that there can be no accumulation of electricity in Voltaic combinations, unless the same or similar conditions of chemical change exist in the elements or single circles composing them; and that under other conditions, the power generated in single circles is either destroyed or diminished according to the opposing nature, or want of conducting power of the chain of intervening bodies. For instance, in the arrangement (mentioned p. 409) of one piece of zinc and one of platinum, the power is doubled by another series of the same kind, destroyed by an arc of platinum, and diminished by an arc of zinc; by a second solution and a second arc of zinc, it is diminished still more; by a third it is nearly, and by a fourth absolutely, *destroyed.*

As the chemical changes always tend to restore the electrical equilibrium destroyed by the contact of the metals

with each other in the fluids, it is evident that in cases in which arcs primarily inactive are connected with those primarily active, the chemical changes produced by the electrical attractions must tend to produce in the primarily inactive parts of the combination an arrangement which must give it a power in direct opposition to that of the primarily active circles; so that when separated, their actions, if any, must be directly the reverse of the other. This result, which I anticipated, I have actually found to be correct; six arcs of platinum in vessels filled with solution of nitre, were connected with a Voltaic battery of 50 pairs of plates; of course each arc gave off oxygen, and collected acid round the pole in the place of the zinc, and afforded hydrogen and collected alkali round the pole in the place of the noble metal: on separating the six arcs from the battery, they were found to possess independent action, the poles which were negative being positive, and those positive being negative: in short, the combination acted as if an original one, consisting of acid, alkali, and platinum.

With arcs of zinc, the results were of the same kind, but the electrical effects were much more distinct: as the tarnished zinc in this case added its own negative power to that produced by the contact with the acid.

In trying similar experiments with six arcs of tin, silver, copper, and other metals, and using different saline solutions, it was found that the reversed electrical effects were most powerful with the most oxidable metals, and the most concentrated and most decomposable solutions; and the weakest arrangement of this kind was with arcs of platinum and pure

water; yet even in this instance the water had become slightly alkaline at one pole, and acid at the other.

These experiments, showing the nature of the chemical changes in combinations made active by their connexion with Voltaic batteries, and the influence of the newly developed chemical agents, fully explain the phenomena of the secondary piles of M. RITTER; and combined with the fact, that the metals are not PERFECT conductors for electricities of very low intensity, they offer a simple and adequate solution of the circumstances observed by M. DE LA RIVE on the interposition of different metallic plates in the fluids connecting together Voltaic combinations.*

From the nature of the chemical changes taking place in each single circle of a common Voltaic battery, it is evident, that if any small part of a battery for some time in action, is separated from the whole, and made to act as a distinct combination, its powers must be feebler than if it had been originally an independent series; for the electrical action occasioned by the chemical agents developed in it, are such as to counteract the effects produced by the contact of the metals. Whereas, if a small Voltaic series is connected with a much larger one, in reverse order, its oxidable in the place of the noble metals, though the whole power of the combination is much weakened by it when in union; yet, when separated, it must act with much greater power, as the chemical changes produced are exactly of the kind which must enhance the primary power of the metals. This deduction (a necessary consequence of the electro-chemical theory) I have

* Annales de Chimie et de Physique, Tom. xxviii. p. 190.

proved by direct experiment. A series of 6 arcs, composed of zinc and copper and solution of nitre, was connected in the proper order with a Voltaic arrangement of 50 pairs, and suffered to remain in connexion for 10 minutes; they were then separated, and made to act as a single battery: their powers were extremely feeble, not certainly one-third as great as those of a combination of the same kind which had been in action (but unconnected) for the same time. Six arcs of copper and zinc were now connected with the same battery of 50, in a reverse or unconformable manner, so that the six plates of zinc gave off hydrogen and attracted alkali, and the plates of copper oxidated and attracted acid. Being separated after a few minutes, and made to act alone, they exhibited powers which appeared three or four times greater than if they had never been in connexion; the zinc resumed a much higher positive, and the copper a higher negative state, than if they had not before been in the antagonist or unconformable conditions.

All these facts bear upon the same point, and confirm the view which I took of the nature of Voltaic combinations in the Bakerian Lecture for 1806; in all of which, whether the destruction of the electrical equilibrium is produced by the contact of metals or fluids, it is always restored by chemical changes, and in which the circulation, if it may be so called, depends upon a union of these causes, the direction of the currents being always opposite in the metallic and fluid parts of the combination, so as to produce what may be regarded as an electrical circle.

VIII. *General observations and practical applications.*

To explain the manner in which different chemical agents in combination, and in a perfectly neutral state, instantly start into an active existence, when exposed to the two electrical poles, it is necessary to assume principles, and take views of corpuscular action of a perfectly novel kind; and as the chief agents are invisible, and probably imponderable, no direct demonstrative evidence can be brought forward on the subject; and different hypotheses may in consequence be applied to it. In assuming the idea of two ethereal, subtile, elastic fluids, attractive of the particles of each other, and repulsive as to their own particles, capable of combining in different proportions with bodies, and according to their proportions giving them their specific qualities and rendering them equivalent masses, it would be natural to refer the action of the poles to the repulsions of the substances combined with excess of one fluid, and the attractions of these united to the excess of the other fluid; and a history of the phenomena, not unsatisfactory to the reason, might in this way be made out; but as it is possible likewise to take an entirely different view of the subject, on the idea of the dependence of the results upon the primary attractive powers of the parts of the combination on a single subtile fluid, I shall not enter into any discussion upon this obscure part of theory, but I shall endeavour to clear the way for elucidations of it by stating some experimental results.

Some solution of nitrate of potassa was introduced into a glass basin of six inches in diameter, and large slips of paper, tinged with litmus and turmeric, were placed below the fluid, and connected with two pieces of foil of platinum; so that the indications of the formation of acid and alkali, in any part of the basin, by electricity, would be instant and distinct. The two pieces of foil were now connected with the poles of a Voltaic battery: it was found that the alkali was developed only at the point or immediate surface of the negative platinum, and the acid in the same manner at the surface of the positive platinum; and they then gradually diffused themselves through the fluid in a circle round the conductors, and there was no appearance of any repulsions or attractions of the menstrua in the line of the circuit.

In various repetitions of this experiment the same result was obtained; the alkaline and acid matters were influenced in their direction only by currents produced by the disengaged oxygen or hydrogen, or the inclination of the vessel; in short, by mechanical causes only: and the same effects were produced on the test papers, as if a spherical piece of acid and an amalgam of potassium had been introduced in the places of the two poles.

Mr. HERSCHEL has shown, by some elaborate and ingenious experiments in the last Bakerian Lecture, that an amalgam of potassium, containing so minute a portion as some hundred thousand parts of its weight is strongly attracted so as to occasion violent mechanical motion, by the negative pole in a Voltaic arrangement: and if it be supposed that the fluid is divided into two zones, directly opposite in their

powers to the poles of the battery, the virtual change may be regarded as taking place in the two extremities of these zones nearest the neutral point; so that by a series of decompositions and recompositions, the alkaline matters and hydrogen separate at one side, and oxygen, pure or in union, at the other.

In this way, the two electricities may be regarded as the transporters of the ponderable matters, which assume their own peculiar characters at the moment they arrive at the point of rest. I shall detail an experiment which I made under a different form some years ago, and which may assist the imagination in the conception of this singular and mysterious mode of action. A flat glass basin, 10 inches in diameter, was filled with water containing $\frac{1}{2000}$ndth part of its weight of sulphate of potassa, in the bottom of which 30 or 40 separate globules of mercury, containing from 10 to 100 grains each, were placed without any regard to order; two wires of platinum from a battery of 1000 double plates, weakly charged, were made to connect the extremities of the water (passing to the bottom of the basin.) As soon as the electrical communication was made, the globules of mercury in or near the current became instantly agitated; their negative poles became elongated, and approached either the positive pole of the battery, or the positive pole of the contiguous globules of mercury, and streams of oxide flowed with great rapidity from the positive toward the negative pole. No hydrogen appeared at the negative poles of the globules of mercury; but after the action had continued a few minutes, and was then suspended, there was an appearance of some

minute globules, owing, as was proved by tests, to the formation and oxidation of potassium which had combined with the mercury, and which, as is evident from Mr. HERSCHEL's researches, had given to that part of the globule in which it had combined its high electro-positive qualities. When the connexion was again made, the same series of constant and violent motions took place; the elongated and negative extremities of every globule moving towards the positive surfaces, and undergoing continual oscillations; but on pouring a small quantity of muriatic acid into the water, so as to make it slightly acid, these phenomena ceased; the masses of mercury resumed their spherical form, hydrogen was given off from the negative surfaces, and all motion and agitation were at an end. The energy of the acid in this case being negative, may be considered as neutralizing the power of the potassium by its immediate contact, and as destroying all the phenomena of attraction by the positive pole.

In the numerous experiments that I made in 1806, on the transfer of acids to the positive pole and of alkalies to the negative pole, there were similar instances in which masses of acid or alkaline matters, by exerting their own peculiar energies, prevented the accumulation of the antagonist elements at their points of rest, so as to destroy, or materially weaken, their power of motion or transport. For instance, in attempting to transfer baryta from the positive to the negative pole, the negative pole being plunged in sulphuric acid, or sulphuric acid to the positive pole, the negative being plunged in a solution of baryta, the re-agents were neutralized, and formed insoluble precipitates at the point of

union of the menstrua; and no baryta reached the negative, and no sulphuric acid the positive pole.

With muriatic acid and salts of silver the case was the same. And when acids and alkalies, forming soluble compounds, were used in similar experiments, a great length of time was required, proportional in some measure to their masses, before a particle of acid reached the positive, or of alkali the negative pole; and the result was not destroyed till after the intermediate combination had taken place to a considerable extent; proving the phenomena of continued decompositions and re-compositions, and showing that the electrical and chemical phenomena are of the same order, and produced by the same cause.

In the Bakerian Lecture for 1806, I proposed the electrical powers, or the forces required to dis-unite the elements of bodies, as a test or measure of the intensity of chemical union. By the use of the multiplier it would be now easy to apply this test; and *accurate* researches on the connexion of what may be called the electro-dynamic relations of bodies to their combining masses or proportional numbers, will be the first step towards fixing chemistry on the permament foundation of the mathematical sciences.

I could enter into some other general views of the pure scientific relations of this subject, and its connexion with thermo-electricity and the phenomena of cohesion; but having already taken up so much of the time of the Society, I shall defer what I have to say on these subjects to another occasion, and I shall conclude with a few practical observations.

A great variety of experiments made in different parts of

the world has proved the full efficacy of the electro-chemical means of preserving metals, particularly the copper sheathing of ships; but a hope I had once indulged, that the peculiar electrical state would prevent the adhesion of weeds or insects has not been realized; protected ships have often indeed returned after long voyages perfectly bright,* and cleaner than unprotected ships, yet this is not always the case; and though the *whole* of the copper may be preserved from chemical solution in steam vessels by these means, yet they must be adopted in common ships only, so as to preserve a portion,—so applied as to suffer a certain solution of the copper;† and an absolute remedy for adhesions, is to be sought for by other more refined means of protection, and which appear to be indicated by these researches.

The nails used in ships are an alloy of copper and tin, which I find is slightly negative with respect to copper, and it is on these nails that the first adhesions uniformly take place: a slightly positive and slightly decomposable alloy would probably prevent this effect, and I have made some experiments favourable to the idea.

In general, all changes in metals which would indicate the power of chemical attraction, are easily determined by electrical means. Thus I found copper hardened by hammering

* The Carnebrea Castle.

† A common cause of adhesions of weeds or shell fish, is the oxide of iron formed and deposited round the protectors. In the only experiment in which zinc has been employed for this purpose in actual service, the ship returned after two voyages to the West Indies, and one to Quebec, perfectly clean.

The experiment was made by Mr. LAWRENCE, of Lombard-street, who in his letter to me states that the rudder, which was not protected, had corroded in the usual manner.

negative to rolled copper; copper (to use the technical language of manufacturers) both *overpoled* and *underpoled*, containing in one case probably a little charcoal and in the other a little oxide, negative to pure copper. A specimen of brittle copper, put into my hands by Mr. VIVIAN, but in which no impurity could be detected, was negative with respect to soft copper.

In general, very minute quantities of the oxidable metals render the alloy positive, unless it becomes harder, in which case it is generally negative. As I have mentioned before, amalgams of the oxidable metals are usually positive, not only to mercury, but even to the pure metals.

There are probably few chemical operations which electrical changes do not influence, and either increase or modify. In the rusting of iron, for instance, the oxide formed by the contact of moisture becomes the negative surface, and exalts the oxidability of the mass of metallic iron, and the rust consequently extends in a circle.

The precipitations of metals have been already traced to causes of this kind, and many metallic solutions must belong to the same order of phenomena.

I have pointed out in former papers some of the cases of electro-chemical protection, which I have no doubt, when the principles are well understood, will be generally adopted; and others are constantly occurring. I shall mention one,—the preservation of the iron boilers of steam engines by introducing a piece of zinc or tin. This in the case of steam boats, particularly when salt water is used, may be of the greatest advantage, and prevent the danger of explosion, which generally arises from the wear of one part of the boiler.

Another application of importance which may be made, is the prevention of the wear of the paddles or wheels, which are rapidly dissolved by salt water.

But I will conclude. Whenever a principle or discovery involves or unfolds a law of nature, its applications are almost inexhaustible; and however abstracted it may appear, it is sooner or later employed for common purposes of the arts and the common uses of life.

XXVIII. *On the discordances between the Sun's observed and computed Right Ascensions, as determined at the Blackman-street Observatory, in the years* 1821 *and* 1822; *with Experiments to show that they did not originate in instrumental derangement. Also a description of the seven-feet Transit with which the observations were procured, and upon which the experiments were made. By* James South, *Esq. F. R. S. Communicated June* 1, 1826.

Read June 8, 1826.

In presenting to the Royal Society the following pages, I am well aware that some apology is necessary; the subject however to which they refer being intimately connected with the progress of astronomy, I am induced to hope that the Society will still receive with indulgence, what would long since have been communicated to them, had other astronomical pursuits allowed me the opportunity.

That the sun's right ascension, found by *observation*, frequently disagrees with that afforded by *calculation*, astronomers I believe now generally admit; an opinion however has been as generally entertained, that the discordances were the results of instrumental inaccuracy, occasioned by the effects of the solar rays upon certain parts of the instrument; hence observations of the sun have fallen into disrepute, whenever an accurate knowledge of the time is the object of research.

As, however, there is nothing which more impedes the advancement of science, than opinions too hastily adopted, it may be worth while to inquire whether practical astronomy

really merits the above reproach; the investigation will be tedious, but I trust it will be satisfactory.

The transit instrument employed for the purpose was made for me by Mr. TROUGHTON; its object-glass is four inches in clear aperture, its focal length seven feet two inches; and as far as the just proportions of its parts are concerned, it is regarded by him, as his happiest production. Experience having also shown that it is one which future artists will do well to *imitate*, a brief description of it will perhaps be grateful to the Society.

The instrument in its general construction is similar to that of the ten feet transit, which was in the year 1816 erected at the Royal Observatory at Greenwich; there are however some trifling differences, which will be mentioned hereafter.

In Plates XVI. and XVII. figures 1 and 6, the instrument is shown on a scale of one-twelfth of the real dimensions. The telescope (as well as the axis), is formed of conical tubes, the extreme ends of which are determined by the diameter of the object-glass, whilst the larger ends take their dimensions from that of the spherical centre piece, which forms a base for them to rest on. In the two figures just referred to, the centre piece has nearly four-sixths of its surface covered by the four truncated cones of the axis and telescope; but it is not rendered weak by the perforations made in it, those in the direction of the telescope being but a little more than the radius of the object-glass, whilst those in the direction of the axis are no larger than is required to transmit the light of a lamp placed near the end of the axis, uninterruptedly to the central illuminator. The figures 1 and 6 of Plates XVI. and XVII. do not at all show how the four

principal parts of the instrument are united to the sphere, but figures 8 and 9 of Plate XVIII. will illustrate a description of what is hitherto *peculiar* to the Greenwich transit instrument and mine.

The ends of all the four cones, where they join the sphere, are strengthened by circular pieces of cast brass ; these pieces extend full three inches into the lengths of their respective cones, into which they are soldered and pinned ; they are turned concave in front, so as to fit the surface of the sphere, into which they are rabbeted, and serve to keep the opposite branches of the axis and telescope straight, and at right angles with each other. To these brass pieces are attached broad and strong rings, for the reception of the screws which bind the whole together.

The four branches of the axis and telescope are solely united, by what Mr. TROUGHTON calls, *tension bars;* these bars pass through the sphere, six of them in the direction of the axis, and four in that of the telescope. They are arranged at equal distances between corresponding parts, care being taken that those of the axis do not obstruct the rays of the object-glass, and that the illuminator is not shadowed by those of the telescope. The tension bars screw into the rings of the brass pieces above described ; they have at one end a fine screw, and at the other a coarse one ; the fine one is made about twice as long as under other circumstances would be required : and there are holes in the sphere at proper distances, through which the bars can pass freely.

To connect these various parts, let the fine screw ends of the six bars of the axis be screwed into their proper rings as far as they will go ; then pass the bars through the holes in the sphere, and pressing the cone home upon the rabbet

retain it there; now address the other cone to the coarse screw ends of the bars, and by turning these in the direction of unscrewing, they will screw into their rings, and bring up the other cone to its bearing, with a power equal to the difference of the ranges of the two screws. The tubes of the telescope are united to the sphere and to each other in the same manner; but to perform this operation, it is necessary to pass the hand into the sphere, for which purpose there are two apertures, with moveable caps left in the middle of its two uncovered parts: the tension bars are acted on by a capstan pin, small holes having been drilled in the bars to receive it. The above caps are covered with platina; on one of them is engraved an inscription, and on the other the maker's name. By the above mode of joining the principal parts, the bars may be stretched, and the sphere* even compressed to any extent short of that, which would occasion a permanent alteration in the length of the former, or in the figure of the latter; a thing which Mr. TROUGHTON considers would perhaps not take place with a force equal to a ton of weight. How much such a connection must be better than any that could be effected by binding together the *exterior* parts, to use the emphatic language of our illustrious artist, "every one who is gifted with mechanical intellect will readily determine."

Plate XVIII. fig. 8, is a section through the axis, and exhibits the six bars which bind together, the cones of the axis, and also the places of the four, which are perpendicular to them, and which connect the tubes of the telescope. In Plate XVIII. fig. 9, which is a section through the telescope,

* That every part of the sphere, should possess a power of resistance, as uniform as possible, extreme precaution was employed, in turning its interior surface, so as to render it concentric with the exterior.

the bars of the telescope are shown lengthwise, whilst those of the axis are perpendicular; in both figures the illuminator is shown, in one the polished surface, the back of the plate in the other; in each it is seen under an angle of 45°, the elliptical perforation appearing as a circle. The removal of the inscription pieces having afforded the draftsman but a limited view of the interior of the sphere, the parts are not represented with precision; but nevertheless may serve well enough to elucidate the preceding description.

In Plate XVII. fig. 6, extending from the cones of the axis to those of the telescope, will be seen four tubes or braces, attached to the former about two inches from the pivots, and to the latter about ten inches from the centre piece; these are so placed as to exert but a very slight pressure, and although deemed by Mr. TROUGHTON *essential* in the Greenwich instrument, were considered *unnecessary* in mine, and for the diminution of expence, would have been omitted but for my interference; in the Greenwich transit they were applied to counteract any disposition to flexure, when the instrument was directed to the horizon; and although the greater length of the Greenwich instrument, would render such an effect more likely to happen than in mine, still, as I had never heard the Astronomer Royal speak but in terms of the highest commendation of *his* instrument, I deemed it consistent with good sense to *profit* by his experience.

Until the Greenwich transit was constructed, the method of placing the telescope to the required altitude, was by means of a semicircle fixed to one of the side pieces, and an index clamped to the pivot of the axis, the vernier of which pressed slightly upon the former. The index in this arrangement is

very liable to be disturbed on reversion of the axis, and when the object-end of the telescope accidentally points below the horizon: also, after the index is set, should the position of the telescope be deranged before the observation is commenced, reference must be again made to the divisions of the semicircle; and should the accident occur whilst the star is passing the wires, the observation will be lost. The apparatus to remedy these inconveniences is seen in Plate XVI. and XVII. figs. 1 and 6, but better in Plate XVI. fig. 2, which is drawn to a scale half the dimensions of the original. It consists of two complete circles, firmly attached to the eye-end of the telescope; each circle is provided with two opposite verniers, subdividing its divisions into minutes of a degree; the indices have clamps and slow moving screws, and microscopes are attached to the verniers: a spirit level is also affixed to the index of each circle, whose range of bubble corresponding to one minute, is about half an inch. When this apparatus is adjusted, on the vernier being set to the place of a star, and the telescope moved round till the bubble stand in the middle of its range, then will the star traverse the field between the two horizontal wires.* Hence it is evident, that should by accident the telescope be moved before, or during observation, the merely restoring the bubble to the middle of its range, will again present the star to the observer's view, without any reference to the divisions. But it is often of importance to observe the transits of stars, one of which, in right ascension differs very little with the other; as for instance, Capella and Rigel; here the index of one circle may be set to the first star, whilst that of the other may be placed to the second;

* These wires are distant from each other, about four minutes of a degree.

Fig. 2.

Eye Piece &c. half the real size.

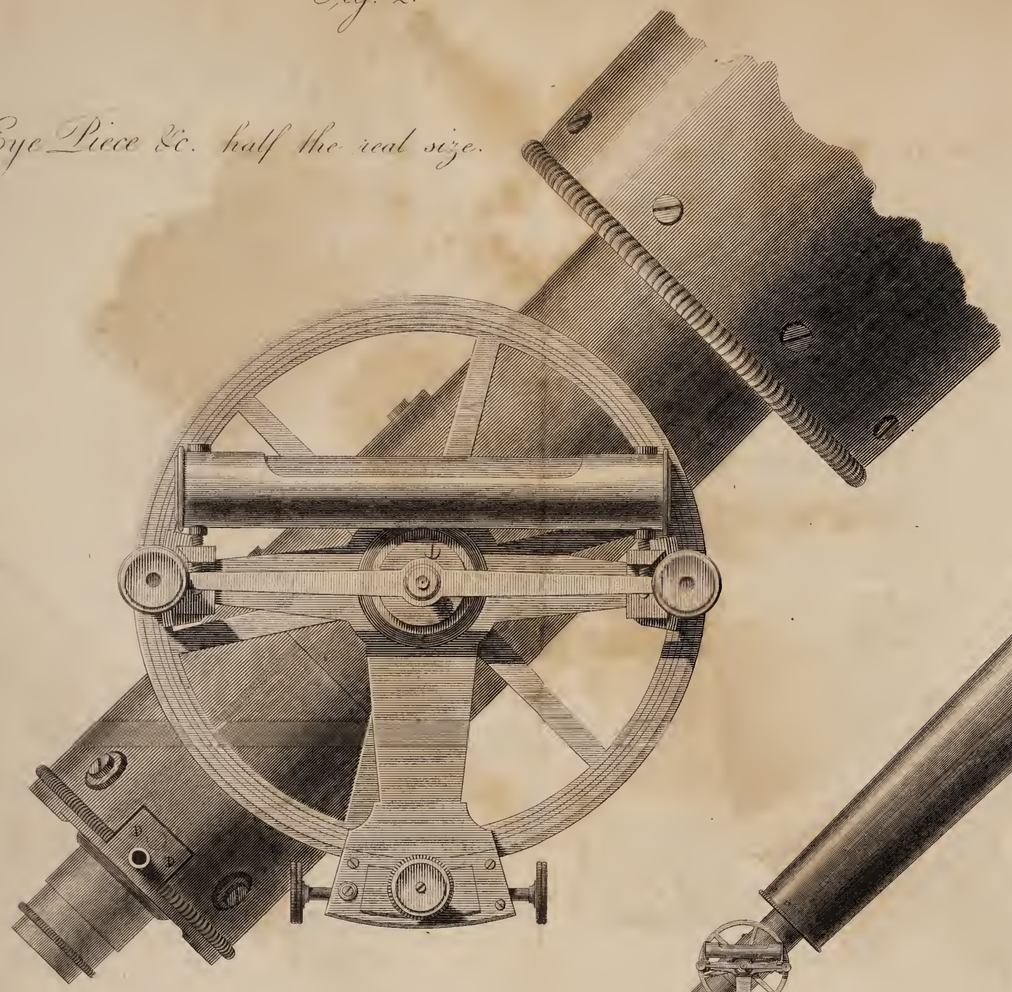
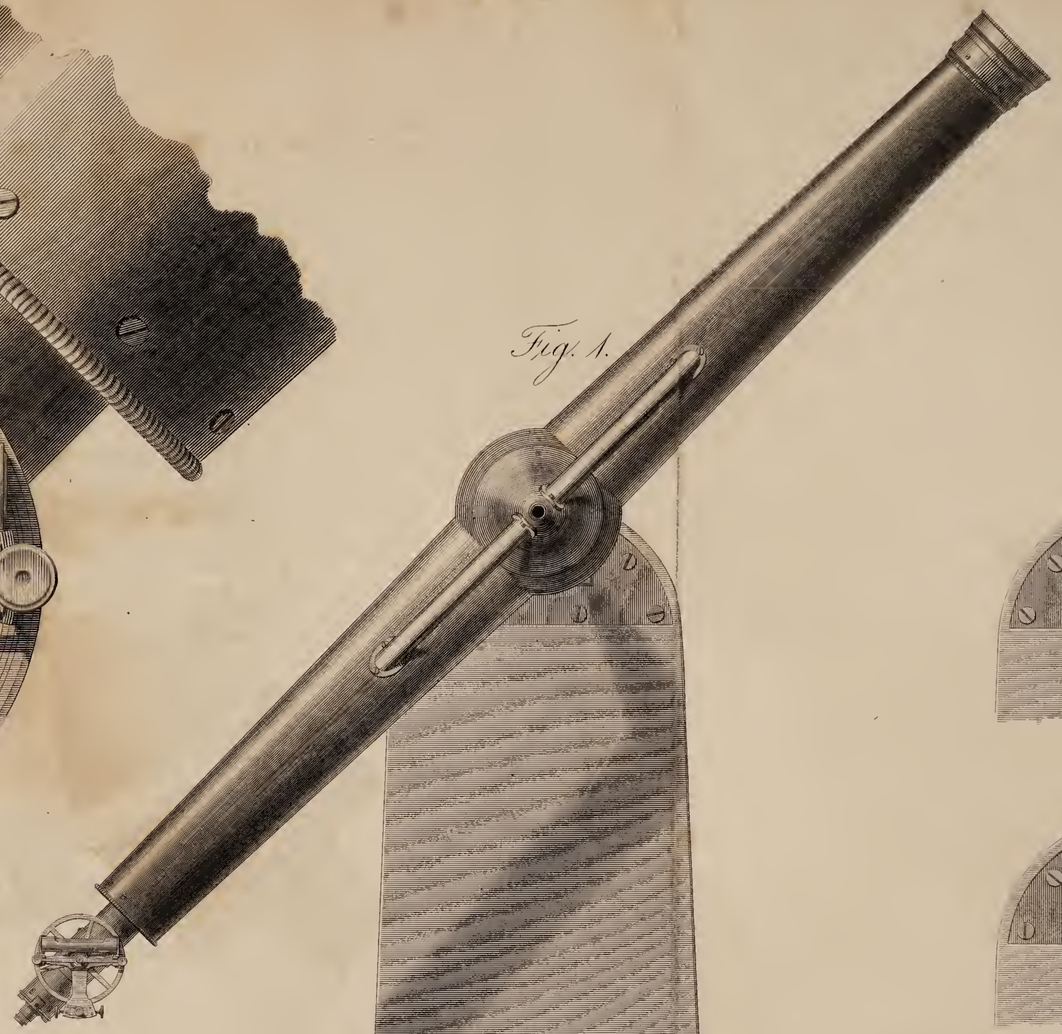


Fig. 1.



The Observing Chair.

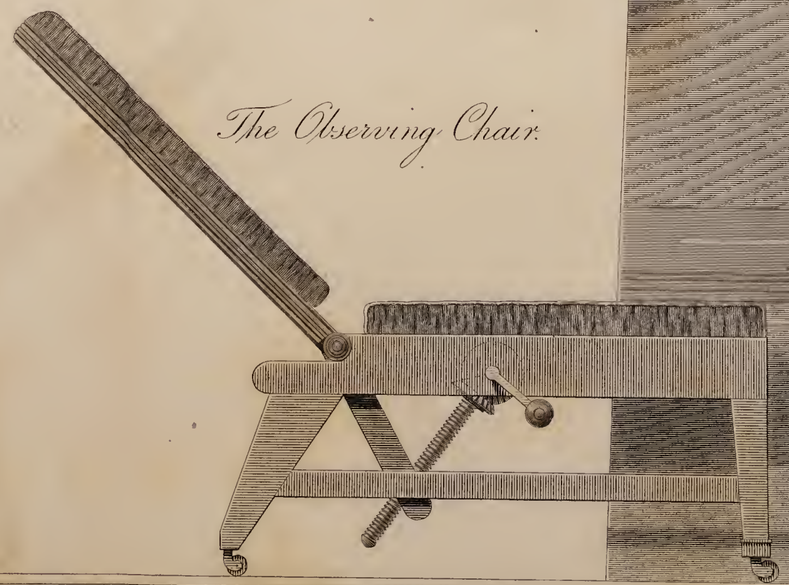


Fig. 3.

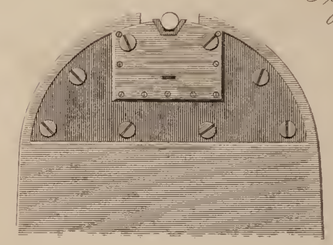
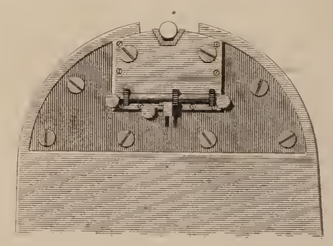
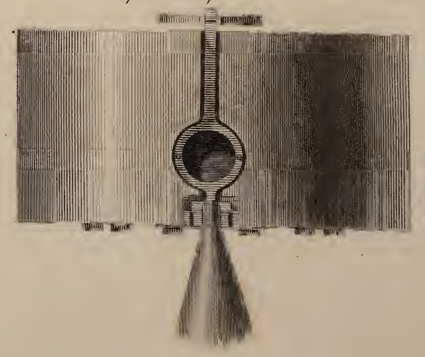


Fig. 4.



Plan of one of the Piers.

Fig. 5.



Scale one Inch to a Foot.

T. Bradley, del.

Made for the Observatory of his Friend James South Esq.re by Edward Troughton.

T. Basire, sc.

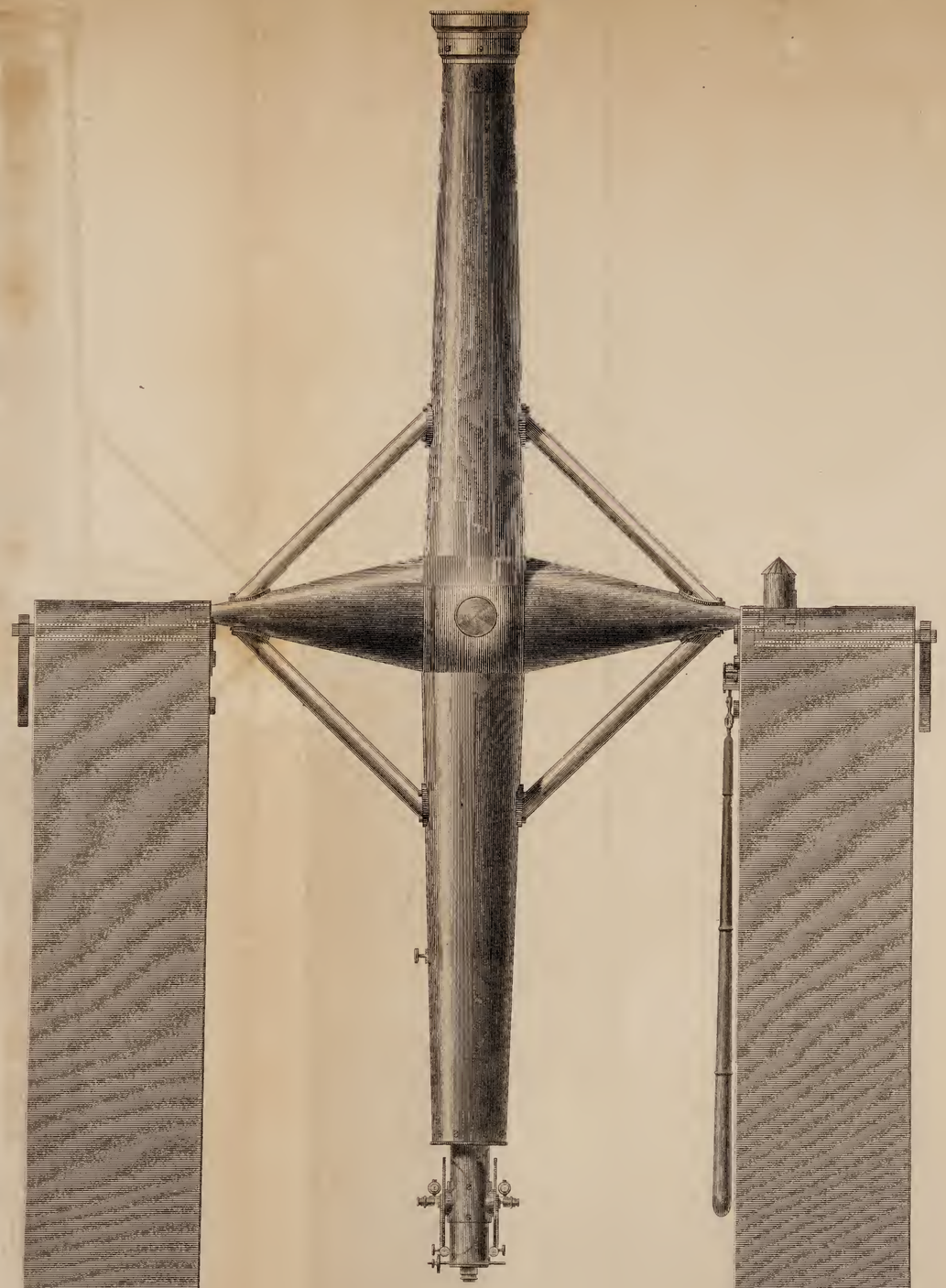
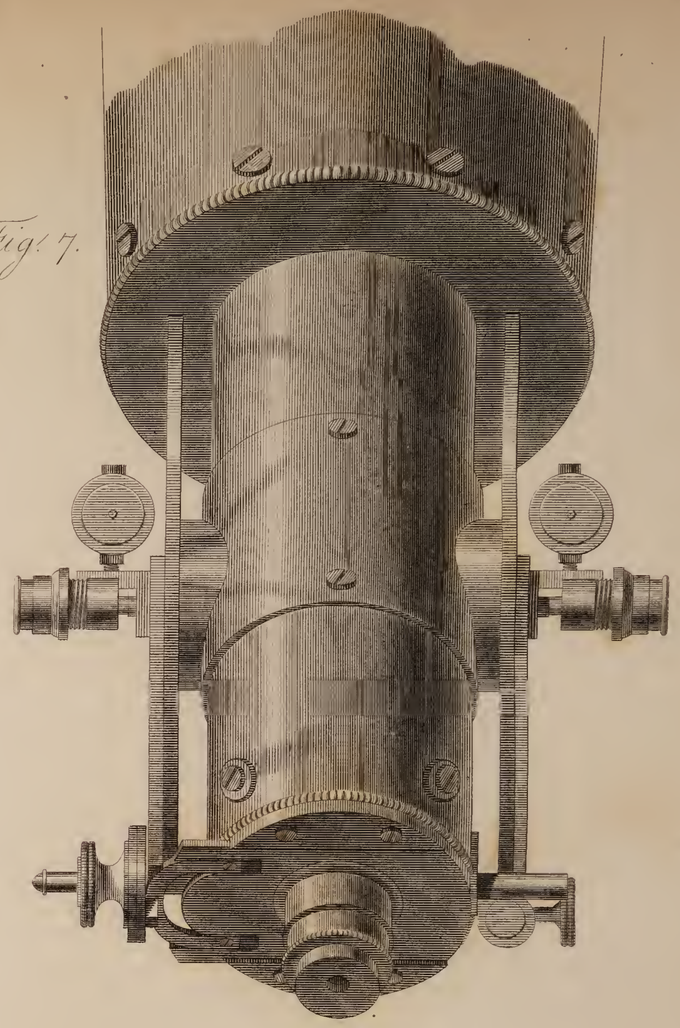


Fig. 6.

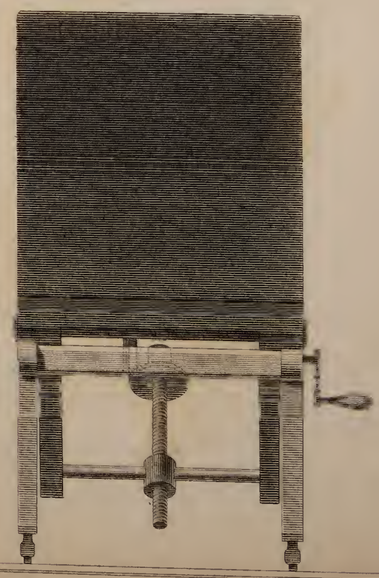
Scale one Inch to a Foot.

Fig. 7.



Front of the Eye Piece.

Back of the Observing Chair.



T. Bradley del.

Section through the Transverse Axis.

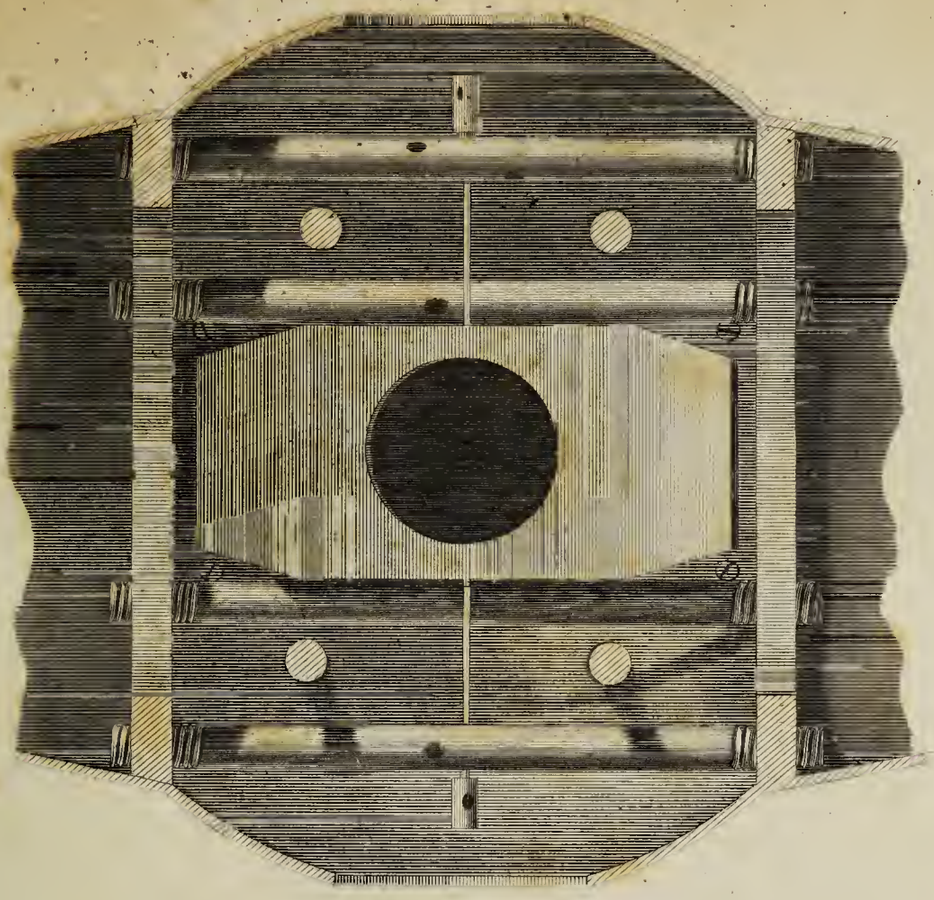


Fig. 8.

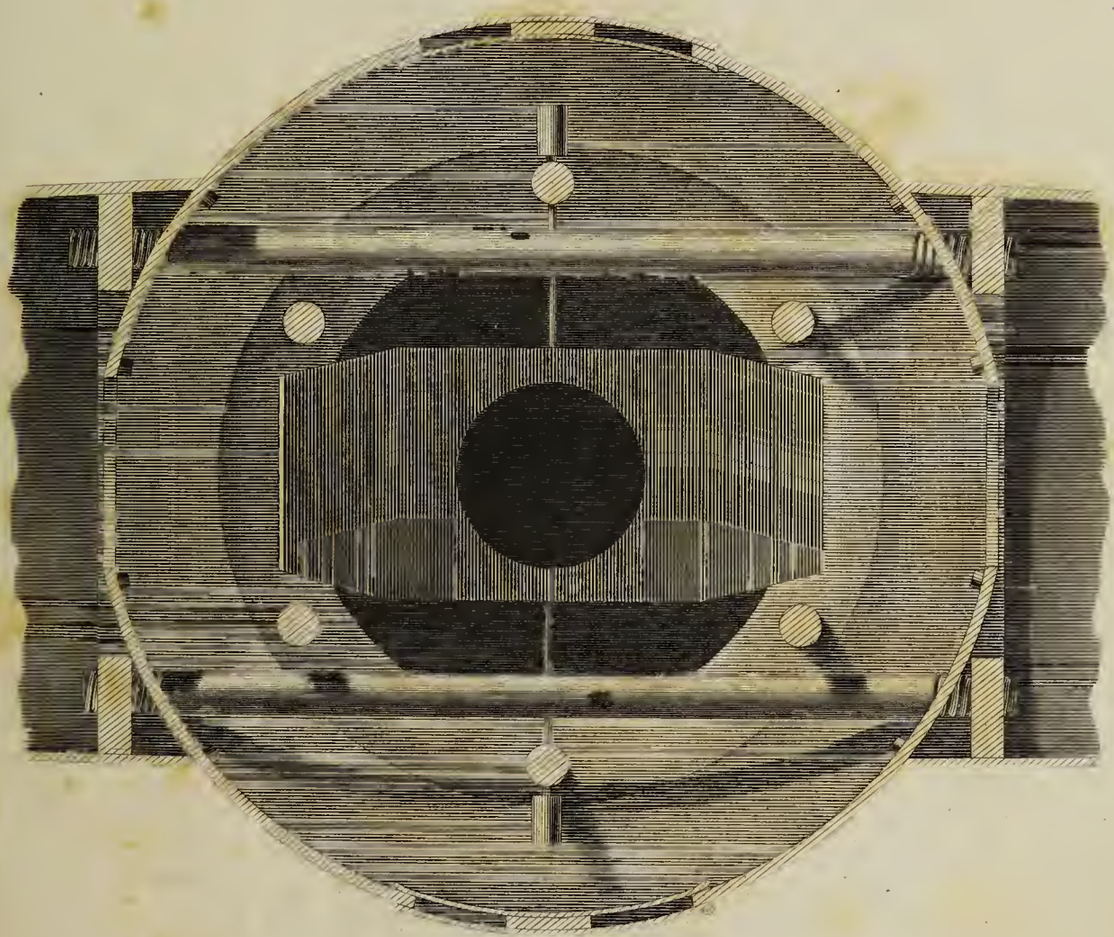


Fig. 9.

Section through the Axis of the Telescope.

Scale of 0 1 2 3 4 5 6 7 8 9 10 11 12 Inches.

Illay del.

and when observations by direct vision, are to be compared with those obtained by reflection, the index of the one, will point the telescope to the direct place of the star, whilst that of the other, will present the instrument to its reflected image.

Figures 3 and 4, of Plate XVI. exhibit the side pieces and Y's in which the pivots of the axis rest; the plates which are semicircular, are imbedded in the stone piers, and are firmly screwed into them. Figure 3, represents the eastern plate, in which the adjustment for the level of the axis is made: a piece, of which the upper end is formed into a Y, is moveable perpendicularly, but well secured from motion in every other direction; the means of gradual adjustment are brought about, by a piece having a short cylindrical part in the middle, at the upper end a fine screw, and at the lower end a coarse one; the fine screw works in the moveable piece, and the coarse one in the fixed plate; the cylindrical part being perforated in many places, enables it to be acted upon by a capstan pin, and thus an effect equal to the difference of the two screws, is produced. This last part, because easy of description, was not brought under the view of the draftsman, by removing the covering plate; a slit in it however exposes two or three of the capstan holes of the differential screw.

Fig. 4, Plate XVI. shows the western plate, the general outline of which corresponds with that just described; the motion of the Y piece is here only horizontal, for the purpose of placing the instrument in the meridian. The adjustment is effected by means of two screws, which work in the opposite sides of the moveable Y piece, and whose heads abut against the fixed plate To produce motion in the Y piece, one of them must be screwed, and the other unscrewed; but in order

that the screws might be both moved at the same time, by equal quantities, and when the observer's eye is at the telescope, there is a system of pinion work, the handle for which adjustment is seen in Plate XVII. fig. 6, hanging down close to the inside of the western pier. In the formation of the side plates very great attention was paid to render them steady in themselves, as also that their respective adjustments should not disturb each other.*

Fig. 5. Plate XVI. is a bird's-eye view of the head of one of the piers, and was meant chiefly to show the apparatus for relieving the pivots of the axis, and Y', from a great part of the weight which would otherwise bear upon them. Immediately behind the adjustable Y piece, but rather broader, is a plain piece of brass, having a Y cut in its upper end; a lever also is seen, one extremity of which passes into a hole made in the Y piece just alluded to, whilst the other end carries a weight; the bar of the lever is expanded into a circle, whose centre is about one-third of the lever's length distant from the pivot of the axis. The circle is sufficiently large to admit the illuminating lantern; in its diameter at right angles to the direction of the lever are inserted two steel screws, whose blunted points are hardened and polished; these rest on hardened and polished steel planes, which are let into the stone pier, and together form the fulcrum in a manner not

* How completely this desideratum has been attained, it is only necessary to remark, that on the 9th of May, 1822, the western side plate was removed from its pier, in order that Mr. TROUGHTON might apply to it, the pinion work just alluded to; on the 19th of the same month it was returned to me; and although not even an approximate meridian mark was at my command, still, by one observation of the pole star on the same evening, the instrument was placed so nearly in the plane of the meridian, that by the subsequent transits of Arcturus and α Libræ, its ex-meridian position could not be detected.

unlike the common balance. The weight is a circular thick plate, or short cylinder, and is hooked on to the end of the lever; it is made hollow, with an opening upon it's superior edge, allowing small shot to be introduced at pleasure, according as it is wished that the instrumental portion of the pivot, as also the instrumental Y piece, should be more or less relieved. A reference to fig. 5, Plate XVI. will render all this perfectly intelligible.

Fig. 7, Plate XVII. is a perspective view of the eye end of the telescope, in which many of the parts above described are differently, and some of them better seen. In it a micrometer is shown, which moves a plate contiguous to that in which the five transit wires are inserted; one wire is contained in the moveable plate, and is intended to facilitate the observations of Polaris, and other juxta polar stars.

In fig. 6, Plate XVII. on the eastern side of the telescope, is seen projecting from it a finger screw; this gives motion to an apparatus within the tube of the telescope, for regulating the quantity of light projected from the illuminator upon the transit wires of the instrument.

The instrument was placed upon its piers on the 6th of June, 1820, and on the day following a series of experiments was begun, to find, if possible, any defects which might invalidate the accuracy of observations hereafter to be made with it; the permanency of the side plates, and of the Y pieces contained in them, was incessantly scrutinized; observations by reflection and by direct vision were compared; continual reversions of the instrument were made; constant examination of the horizontality of the axis, after every alteration of instrumental position, was never omitted; and the state of its

collimation was frequently ascertained.* The results having satisfied my astronomical friends as well as myself, that the instrument fulfilled all the required conditions, further experiments were deemed unnecessary; and on the 5th of August, the instrument being relieved from its two months' "torture," was prepared to grapple with the delicate observations for which it was designed.

The character which the instrument acquired shortly after its erection, four years' subsequent experience has unequivocally confirmed; and exclusive of the property which it is the object of the subsequent pages to investigate, I know not whether most to respect it, for the *unusual* accuracy with which it obeys its adjustments, or for the *extreme* pertinacity with which it retains them.

The object glass of the Greenwich Transit instrument is five inches in clear aperture; its focal length is 10 feet; its horizontal axis, including the pivots, is 3 feet 10 inches; in the focus of the object glass are seven fixed wires, and two moveable for micrometrical purposes; the semicircles at the eye end of the telescope, being insufficient to enable the

* The proximity of lofty buildings to the north and south of my Observatory, rendering it impossible to erect any object to perform the offices of a meridian mark, an apparatus was planted upon the top of my house, enabling me to examine the collimation, by the flag-staff on Severndroog Castle. The trouble, however, of frequently repeating the operation became so considerable, and from unfavourable state of atmosphere, occasionally so unsatisfactory, that sidereal observations were recurred to, generally of Polaris, and of a small star about 54 minutes from the pole: these, particularly the latter, offer severe tests for the accuracy of the adjustment; and where the instrument can be reversed, without risk of deranging its *horizontality*, (as is the case with *mine*,) no error of collimation, sensible to observation, *need* remain uncorrected.

observer to direct the instrument to the reflected image of a star, a divided circle two feet in diameter, is attached to one end of the axis; the pivots, originally of hard bell metal, having suffered an alteration of figure from constant use, were removed during the spring of last year by Mr. TROUGHTON, and others, made of hardened steel, inserted in their stead. There is no apparatus whereby the observer, whilst making sidereal observations, can communicate to the instrument, azimuthal motion.

With these exceptions, the Greenwich Transit is the same as mine; the description therefore given of the one, will convey nearly an accurate idea of the nature of the other.

The computed Right Ascension of the Sun, with which his Right Ascension as determined by observation, will be compared in the subsequent pages, is that given in the Nautical Almanac and Astronomical Ephemeris for the respective years, where it stands computed for the meridian of Greenwich; the comparisons, however, being those arising from observations made at another station, *viz.* Blackman-street Observatory, it becomes necessary to inquire, how far equations can be found, adequate to reduce the sun's right ascension computed for Greenwich, to his right ascension when on the meridian of Blackman-street. This is a matter which observation must decide.

Tables I. and II. show various right ascensions of the sun observed in Blackman-street during the years 1821 and 1822; the former presents sixteen, the latter nineteen transits of the sun made on consecutive days; the maximum difference between the *observed* daily motion in right ascension

and the *computed* daily motion in right ascension, is 26 hundredths of a second in the one, and 22 hundredths in the other; in the former table the mean difference of sixteen comparisons is only 4 hundredths of a second in time, whilst in the other it is only 3 hundredths. Hence, there can be no doubt, that we may safely enough employ the computed daily motion in right ascension, to arrive at accurate corrections of the sun's computed right ascension, for the differences of longitude of the two observatories.

Tables III. and IV. contain the sun's right ascension computed for the meridian of Blackman-street, on such days as the sun's transit was observed there, during 1821 and 1822, also the equations employed for the purpose; the longitude of Blackman-street Observatory being 21.76 seconds of time west of the Royal Observatory at Greenwich.

Tables V. and VI. exhibit the difference between the sun's observed and computed right ascensions, as determined in Blackman-street during the years 1821 and 1822; these require explanation.

The Observatory being situated in one of the principal manufacturing, as well as in one of the most populous, districts of the metropolis, the instruments were exposed to the inconveniences of soot falling upon them, from the chimneys of the neighbouring houses, steam engines, &c.; and the transit, from the nature of the opening in the roof, came in for its full share: to protect its tubes, therefore, from the ravages of the soot, they were, shortly after the erection of the instrument, covered with green woollen cloth, which being neatly fitted and attached by buttons, afforded no incumbrance during the observations. The openings in the roof to the

north and south were about 18 or 20 inches in breadth; and the telescope, when directed to the zenith, extended some way between the ceiling of the observatory and its roof. The shutters were so contrived as to be opened in an instant; and by a slight frame-work it was very easy to screen all the parts of the instrument, and also the piers, from the access of the sun's rays; it was likewise a matter of the greatest facility to prevent his rays from falling on the eastern half of the instrument, whilst the western was exposed to their influence.

Previous to observing the sun's transit, it was my ordinary habit not to open the shutter, till his first limb had nearly reached the first wire of the instrument. This precaution was uniformly adopted, in the observations of 1821, till the 22d of August; the consequences are seen by the annexed differences.

If, however, we adopt the hypothesis, that the mere exposure of the instrument to the sun's rays during the observation of his transit (a period about $4\frac{1}{2}$ minutes) be adequate to produce instrumental derangement corresponding to 8 or 9 tenths of a second in time, it is fair to expect that a longer exposure would produce a greater discordance, and vice versâ. On the 22d of August, therefore, the western * half of the instrument was exposed to the solar rays, 18 minutes before the sun's centre came to the meridian; the effect, however, being very inconsistent with theory, on the 23d it was exposed 24 minutes; the mean differences of temperature of the western and eastern axes, and western and eastern

* By the nature of the roof, and the construction of the interior of the observatory, independently of the shutter and screen, the sun's rays could not fall on the eastern brace and axis, 'till the sun had nearly reached the meridian; but the western brace and axis, towards the pivot, were accessible to his rays nearly $1\frac{1}{2}$ hour before noon, provided the shutter was opened.

braces being 14 degrees, but without any evidence of increased displacement.

On the 24th of August, the western half of the instrument was exposed 65 minutes before noon, still without any material difference; indeed, if the observations could be relied upon (which they certainly cannot), to 7-hundredths of a second of time, the result of this day's exposure of the instrument, would militate against the hypothesis, that the sun's rays have any thing to do with the matter, seeing that the difference is in the negative sense.

On September 2nd, all the coverings were removed from the instrument, and it was defended from the solar rays, till the sun's first limb had nearly reached the first wire. On September 3rd, the instrument* without its coverings, was exposed to the sun's rays, 59 minutes before his centre came to the meridian; the difference between the thermometers on the western axis and brace, and those on the eastern, being nearly 14 degrees, yet the discordance between the results of the two days transits, is absolutely insensible.

On September the 4th, the instrument was entirely defended from the sun's rays. On the 5th, the western braces and axis, also the western half of the centre piece being covered with black cloth, whilst those on the eastern half were enveloped in white, the instrument was exposed 65 minutes before noon, to the sun's rays; thermometers placed under the covers of the western axis, and western brace, stood 13°.5 higher, than those placed under the covers of the eastern axis and brace; yet the discordance between the observed and computed right

* Previously to the shutter being opened, for the experiments of exposure, the instrument was always elevated to the sun's altitude; and it remained so, until the transit was observed: during the experiments, the windows and door of the observatory were closed; the thermometers employed, were made by Mr. TROUGHTON.

ascensions, varies only one thousandth of a second, from the quantity obtained on the 4th, when the instrument was entirely defended from the solar rays.

On September 24th, the instrument was completely screened from the sun's rays; but on the 25th they were allowed to fall upon the instrument's western axis and brace, sixty-three minutes, during a cloudless sky;* yet between the results of the one day, and the other, there is only a difference of 7 hundredths of a second.

On October 21st and 22nd, the instrument being exposed to the sun's rays, thermometers under the black covers of the western axis and brace, differed on the former day 12°.5 from those under the covers of the white axis and brace; but on the latter, the difference of temperature was more than 16°; the difference between the results of the two days' observations, is nine hundredths of a second: unfortunately, there are no observations with which these can be compared.

In like manner might we discuss individually, the results of experiments made on several occasions, during the year 1822; the days however are noted in Table VI. when the instrument was exposed; and Table VII. details all the particulars which are essential to the investigation; to which therefore the reader is referred, as also for a more circumstantial account of the exposure of the instrument to the sun's rays, during the year 1821.

On looking down the columns of differences, between the *observed* and *computed* right ascensions of the sun, from the

* Experiments during exposure of the instrument, were never commenced, except under every probability of success; when however (as frequently happened), transient clouds obscured the sun, even but for half a minute, the operations were discontinued, and the results disregarded and destroyed.

various determinations of 1821 and 1822, exhibited in Tables V. and VI. it will be seen, although the difference is not constant, yet that within two or three days, its amount does not greatly vary; by collecting therefore consecutive transits, in pairs, each of which shall always contain a result, derived from observation made during exposure of the instrument, we may probably arrive at some conclusion, which, although not demonstrative, will still merit considerable confidence. Let us begin with 1821.

From Table V. 1821.

Instrument exposed.		Instrument defended.		Difference.
	seconds.		seconds.	seconds.
August 22	+ 0.755	August 21	+ 0.733	+ 0.022
Sept. 3	+ 0.672	Sept. 2	+ 0.661	+ 0.011
—— 3	+ 0.672	—— 4	+ 0.661	+ 0.011
—— 5	+ 0.660	—— 4	+ 0.661	— 0.001
—— 25	+ 0.701	—— 24	+ 0.773	— 0.072
		Mean diff. of the 5 pairs =		— 0.0058

From Table VI. 1822.

Instrument exposed.		Instrument defended.		Difference.
	seconds.		seconds.	seconds.
March 1	+ 0.030	February 28	+ 0.225	— 0.195
May 21	+ 0.861	May 22	+ 0.932	— 0.071
—— 31	+ 0.971	June 1	+ 0.826	+ 0.145
June 2	+ 0.826	June 1	+ 0.826	+ 0.000
—— 2	+ 0.826	June 3	+ 0.873	— 0.047
—— 4	+ 0.704	June 3	+ 0.873	— 0.169
—— 7	+ 0.705	June 6	+ 0.927	— 0.222
Decem. 22	+ 0.164	Decem. 23	+ 0.158	+ 0.006
		Mean diff. of the 8 pairs =		— 0.0691

Hence, in 1821, the mean of 5 observations, obtained when the instrument was exposed to the sun's rays, varies from

the mean of 5 observations, made when the instrument was entirely defended from their influence, six thousandths of a second of time; whilst in 1822, the mean derived from 8 observations made under exposure, compared with the mean of 8 results, obtained when the instrument was completely defended from the sun's rays, differs sixty-nine thousandths of a second of time.

The mean therefore of the two series, allowing each, a weight proportional to the number of observations on which it rests, is forty-five thousandths of a second of time. Whether this arise, from error of observation, erroneous computation, or from instrumental derangement, we have not sufficient data* to determine: fortunately, however, the quantity is very small, and if it really *could* be brought, to support the hypothesis, " that the sun's rays falling unequally upon the instrument, occasioned the discordances complained of," it would lose much of its apparent weight, when it is remembered, that not the ordinary exposure of the instrument to the sun, but ten times that quantity, was employed to procure it.

The mean difference however between the observed and computed right ascensions is *less* under exposure, than when the instrument was defended; hence, were it wanted, it might be called upon as additional evidence, in favour of the conclusion which the experiments afford, namely, " that the discordances between the *observed* and *computed* right ascen-

* On referring to page 446, there seems some reason to believe, that the differences found between the observations of February 28th and March 1st, May 31st and June 1st, June 3rd and June 4th, June 6th and June 7th, are *not* the results of instrumental derangement, *nor* of erroneous observation. The Greenwich and Paris observations corroborate our 1st difference; the mean of the Greenwich and Paris, supports our 2d; the Paris determination coincides with our 3d; and the Dublin is nearly similar to our 4th.

sions, as determined by the Blackman-street observations of 1821 and 1822, were *not* the consequences of instrumental inaccuracy."

To obtain however these results, we have been obliged to recur to the sun's right ascension, as computed in the Nautical Almanac; it is therefore possible, that the near coincidences above indicated, may arise from a balance of errors, between derangement of the instrument on the one hand, and inaccurate calculation on the other; we will therefore appeal to experiments, which shall be independent of astronomical tables.

The brightness of the pole star, and the difference of polar distance between it, and the sun, render it visible in the day time, throughout the year: during the spring and autumn, it comes to the meridian about noon; in the former, at its superior, in the latter, at its inferior transit; in the one instance, the sun is about 8° north, in the other as much south of the equator; the arc therefore intercepted between the star and the sun, being about 20° greater in autumn, than in the spring, observations of the star, will be gotten with greater facility in the former, than in the latter.

With the ordinary observing power of 250, the transit of the star, when *very* steady, may be determined by my instrument, to half a second of time. If therefore, the sun's rays can occasion such instrumental derangement, as may be easily perceptible by the sun's transit, we must expect that their power will be incontrovertibly established, if observations of the pole star, made under exposure of the instrument to the sun's rays, be compared with those made, when the instrument is defended from them.

Table VIII. shows the observed transits of the pole star, during the autumns of 1821 and 1823; also the nature

and extent of the exposure, to which the instrument was subjected.

Table IX. indicates the portions of time, in which the pole star passed to the several wires, when the instrument was exposed to the sun's rays; whilst Table X. gives the like information, when the instrument was entirely defended from them.

Table XI. shows the difference between the intervals of time, in which the pole star passed to the several wires, when the instrument was exposed to, and defended from, the sun's rays; and the results for two adjoining wires, are as follow:

Seconds.	
− 0.17	From the observations of 1821.
− 1.25	
− 1.00	
+ 0.17	
+ 1.25	
− 1.00	
− 0.87	
+ 0.57	From the observations of 1823.
− 0.33	
+ 0.50	
+ 0.50	

Mean = − 0.15

Thus it seems, that the time taken by the pole star to pass over any two adjoining wires of the instrument, is *less* when the instrument is exposed to the sun's rays, than when it is defended from them, by 0.15 of a second; which, when quadrupled, and referred to the sun's mean polar distance, is less than two hundredths of a second of time.

The quantity is nearly insensible; and considering that an exposure at least ten times as great, as the instrument receives during an ordinary observation of the sun's transit, was required to produce it, I am led to the conclusion, "that the discordances between the *observed* and *computed* right ascensions of the Sun, as determined by the Blackman-street observations of 1821 and 1822, did *not* arise, from instrumental derangement."

But it may be urged that, although the experiments here narrated, prove that the differences between the sun's observed and computed right ascensions, cannot have arisen from derangement of the instrument employed in obtaining them, still there may be some peculiarity in the eye, or the judgement of the observer, which, if it exist at all, will exist as well in the observations made during exposure, as in those made, when the instrument was defended. This is a point which must be cleared up. If the differences really be as great, as my observations make them, it is fair to expect they cannot have escaped detection, in other observatories. As being easily accessible, and better known in this country than any other, let us appeal to the corresponding observations, at the Royal Observatory of Greenwich, the Royal Observatory of Paris, and the Dublin Observatory.

Our Astronomer Royal, having very obligingly transmitted me a copy of such corresponding observations, as were procured at Greenwich, the comparison with the Blackman-street determinations, is extremely easy, the same mean right ascensions of the standard stars, as also the same corrections, having been used at the two stations.

The Paris and Dublin results, will require reductions to

render them comparable with the observations of Blackman-street, and Greenwich; Mons^r. BOUVARD having, however, kindly annexed to the Paris observations, the names of the stars used each day, in determining the clock's error, and having also put me in possession of the catalogue used at the Paris observatory, to find equations, by which each observation might be expressed in terms of the Greenwich catalogue, became only a matter of calculation.

Dr. BRINKLEY having likewise been equally indulgent, the Dublin observations are, by similar treatment, available to my purpose.

Tables XII. and XIII. contain the sun's right ascension computed for the meridian of Paris, on such days as the sun's transit was observed at the Paris, and Blackman-street observatories, during 1821 and 1822; whilst Tables XIV. and XV. answer the same purpose for the meridian of Dublin. The longitude of the former, being assumed as $9^{min.}\ 21^{sec.}$ of time east; whilst that of the latter is regarded as $25^{min.}\ 22^{sec.}$ of time, west of the Royal Observatory at Greenwich.

Tables XVI. and XVII. exhibit the sun's right ascension, as observed at Paris, by the Paris Catalogue, in values of the Greenwich Catalogue; and Tables XVIII. and XIX. serve the like purpose to the Dublin observations, reduced by the Dublin Catalogue.

Tables XX. and XXI. show the differences between the sun's observed and computed right ascensions, by Greenwich observations of 1821 and 1822.

Tables XXII. and XXIII. indicate the differences by Paris observations; and Tables XXIV. and XXV. exhibit the discordances by Dublin observations.

Table XX. shows us, that the mean of 31 observations made at Greenwich in 1821, gave the observed right ascension of the sun, greater than his computed right ascension, 0.627 of a second of time.

And Table XXI. informs us, that by the mean of 45 observations, made at Greenwich in 1822, the observed right ascension, was found greater than the computed, 0.420 of a second.

Table XXII. presents us with the mean of 16 observations of the sun, made at the Royal Observatory of Paris in 1821, whereby his observed right ascension, exceeds his computed right ascension, 0.584 of a second.

And Table XXIII. indicates, that by 28 observations made at the Paris Observatory in 1822, the observed right ascension, was found greater than the computed right ascension, 0.558 of a second.

Table XXIV. offers to our notice, 9 observations of the sun, made in the year 1821, at Dublin; whereby the observed right ascension, was determined to be greater than the computed, 0.666 of a second.

And Table XXV. exhibits 15 observations made in 1822, at the Observatory of Dublin, giving the observed right ascension of the sun, greater than his computed, by 0.686 of a second of time.

The two following Tables will facilitate the comparison of the results, as obtained at the respective observatories.

Table exhibiting the Discordances between the Sun's observed and computed Right Ascensions, as determined at the Observatories of Blackman-street, Greenwich, Paris, and Dublin.

1821.

	Blackman-street.	Greenwich.	Paris.	Dublin.
	seconds.	seconds.	seconds.	seconds.
June 30	+ 0.834	+ 0.780	.....	+ 0.939
July 9	0.926	0.830	.....	.....
12	0.805	0.690	.....	0.864
18	1.062	0.770	+ 0.275	.....
19	0.978	0.580	0.532	0.811
August 3	0.756	0.670	.....	.....
4	0.654	0.470	.....	.....
10	0.897	0.770	.....	.....
11	0.771	0.470	.....	.....
17	0.594	0.830	.....	.....
20	0.990	0.660	0.674	.....
21	0.733	0.940	0 411	.....
22	0.755	0.720	0.688	.....
23	0.753	0.450	0.916	0.662
24	0.679	0.570	0.822	0.869
September 2	0.661	0.840	0.812	.....
3	0.672	0.690	.....	.....
4	0.661	0.650	0.648	.....
5	0.660	0.350	0.667	.....
12	0.803	.....	.....	.....
15	0.681	0.570	.....	.....
16	0.808	.....	.....	.....
24	0.773	.....	.....	.....
25	0.701	.....	.....	.....
October 2	0.795	0.550	0.415	0.357
21	0.729	0.890	0.918	.....
22	0.640	0.670	.....	.....
29	0.529	0.410	0.445	0.501
30	0.608	0.640	0.330	.....
November 6	0.566	0.610	0.366	.....
December 2	0.576	.....	.....	.....
4	0.623	0.610	+ 0.417	.....
5	0.423	0.090	.....	.....
6	0.564	0.900	.....	0.569
8	0.453	0.370	.....	.....
11	+ 0.503	+ 0.380	.....	+ 0.419

Table exhibiting the Discordances, between the Sun's observed and computed Right Ascensions, as determined at the Observatories of Blackman-street, Greenwich, Paris, and Dublin.

1822.

	Blackman-street.	Greenwich.	Paris.	Dublin.
	seconds.	seconds.	seconds.	seconds.
January 15	+ 0.476	+ 0.180	+ 0.072	.....
16	0.500	0.440	.....	.....
February 21	0.603	0.340	0.637	.....
23	0.379	0.230	0.370	.....
24	0.579	0.000	.....	.....
28	0.225	+ 0.150	0.610	.....
March 1	0.030	— 0.100	0.436	.....
April 30	0.715	+ 0.300	0.173	.....
May 1	0.705	0.230	0.466	+ 0.672
21	0.861	0.790	0.490	0.913
22	0.932	0.590	1.084	0.865
24	0.597	0.550	.....	0.777
27	0.983	0.670	.....	.....
31	0.971	0.330	0.771	.....
June 1	0.826	0.480	0.233	0.630
2	0.826	0.570	0.627	.....
3	0.873	0.430	0.819	0.806
4	0.704	0.460	0.631	.....
6	0.927	0.680	0.606	1.007
7	0.705	0.320	1.137	0.727
22	0.694	0.570	.....	0.752
July 4	0.879	.....	0.605	.....
7	1.095	0.700	.....	.....
10	0.974	.....	1.081	.....
31	0.889	0.430	.....	.....
August 1	0.670	0.310	0.972	.....
2	0.812	0.570	0.868	0.722
3	0.736	0.820	.....	.....
4	0.697	0.600	.....	.....
8	0.834	0.420	.....	.....
9	0.864	.....	.....	.....
17	0.665	0.460	0.384	.....
18	0.743	0.420	0.351	.....
19	0.563	0.150	.....	0.535
21	0.576	0.540	.....	0.372
October 14	0.633	.....	.....	.....
November 4	0.430	0.320	.....	.....
9	0.367	0.000	.....	.....
13	0.342	0.310	.....	.....
14	0.432	0.320	.....	0.301
26	0.305	.....	0.412	.....
29	0.467	0.480	.....	.....
December 6	0.543	0.540	0.383	.....
7	0.525	0.470	0.667	0.658
8	0.395	0.590	.....	.....
22	0.164	0.370	0.121	.....
23	0.158	0.280	.....	.....
26	0.372	0.410	0.159	+ 0.552
28	0.279	0.390	+ 0.447	.....
30	+ 0.492	+ 0.800	.....	.....

Hence we find for 1821,

That 31 observations made in Blackman-street, gave the sun's observed right ascension, greater than the computed, - - - - seconds. 0.708

And by 31 correspondent observations at the Royal Observatory of Greenwich, the observed right ascension, was found greater than the computed, 0.627

That 16 observations made in Blackman-street, gave the sun's observed right ascension, greater than the computed, - - - - - 0.736

And that 16 observations on corresponding days, made at the Royal Observatory of Paris, determined the observed right ascension, to exceed the computed, - - - - - - 0.584

That 9 observations made in Blackman-street, found the sun's observed right ascension, greater than his computed right ascension, - - - 0.716

And that 9 correspondent observations made at Dublin, found the observed right ascension, greater than the computed, - - - 0.666

And during 1822,

That 45 observations made in Blackman-street, determined the sun's observed right ascension, to be greater than the computed, - - - seconds. 0.608

And that 45 observations made at the Royal Observatory at Greenwich, on corresponding days, gave the observed right ascension, greater than the computed by, - - - - - 0.420

	seconds.
That 28 observations made at the Observatory in Blackman-street, found the observed right ascension, to exceed the computed, - - -	0.632
And that by 28 corresponding observations at the Royal Observatory of Paris, the observed right ascension, was determined to be greater than the computed, - - - - - -	0.558
That by 15 observations in Blackman-street, the observed right ascension, was found greater than the computed, by - - - -	0.693
And that 15 correspondent observations made at the Observatory of Dublin, the observed right ascension, exceeded the computed, by - -	0.686

Seeing therefore that results not materially differing from the Blackman-street determinations, are derived from the Greenwich, the Paris, and the Dublin observations, it is reasonable to conclude, that the discordances between the observed and computed right ascensions of the sun, as found by the Blackman-street observations, did not arise from any peculiarity in the eye, or judgement of the individual employed, in obtaining them.

We have however hinted in a former part of this memoir, that the differences as determined in Blackman-street, were not constant; and by reference to the preceding tables, discordances amongst them, to an amount far greater than can be attributed to erroneous observation, will readily be detected; hence, an investigation into their nature, becomes desirable; this, however, would lead us into an inquiry beyond the purport of the present communication; which, besides a

brief description of an admirable instrument, was intended chiefly to show, " that the discordances between the *observed* and *computed* Right Ascensions of the Sun, as determined at the Blackman-street Observatory, in the years 1821 and 1822, did *not* originate, in *instrumental* inaccuracy."

I hope however ere long to show, to the satisfaction of the Society, that the source of the discordances, must be sought for, in the imperfections of the Solar Tables.

JAMES SOUTH.

Sloane-street, N°. 132.
May 24, 1826.

Table I.

To show the Differences which exist, between the Sun's observed daily motion in Right Ascension, and his computed daily motion in Right Ascension; (by Blackman-street observations.)

1821.

		Sun's observed Right Ascension.	Observed daily motion in R. A.	Computed daily motion in R. A.	Diff. of the observed and compd.
		h. m. s.	m. s.	m. s.	s.
July	18	7 49 40.623	4 0.916	4 1.000	—0.084
	19	7 53 41.539			
August	3	8 52 49.015	3 51.598	3 51.700	—0.102
	4	8 56 40.613			
	10	9 19 38.255	3 47.274	3 47.400	—0.126
	11	9 23 25.529			
	20	9 57 8.647	3 42.143	3 42.400	—0.257
	21	10 0 50.790			
	—	10 0 50.790	3 41.921	3 41.900	+0.021
	22	10 4 32.711			
	—	10 4 32.711	3 41.398	3 41.400	—0.002
	23	10 8 14.109			
	—	10 8 14.109	3 41.026	3 41.100	—0.074
	24	10 11 55.135			
September	2	10 44 47.316	3 37.411	3 37.400	+0.011
	3	10 48 24.727			
	—	10 48 24.727	3 37.189	3 37.200	—0.011
	4	10 52 1.916			
	—	10 52 1.916	3 36.899	3 36.900	—0.001
	5	10 55 38.815			
	15	11 31 37.636	3 35.527	3 35.400	+0.127
	16	11 35 13.163			
	24	12 3 57.928	3 36.028	3 36.100	—0.072
	25	12 7 33.956			
October	21	13 43 7.287	3 47.511	3 47.600	—0.089
	22	13 46 54.798			
	29	14 13 47.288	3 53.380	3 53.300	+0.080
	30	14 17 40.668			
December	4	16 42 19.690	4 21.200	4 21.400	—0.200
	5	16 46 40.890			
	—	16 46 40.890	4 21.941	4 21.800	+0.141
	6	16 51 2.831			
				Mean =	—0.040

Table II.

To show the Differences which exist, between the Sun's observed daily motion in Right Ascension, and his computed daily motion in Right Ascension; (by Blackman-street observations.)

1822.

		Sun's observed Right Ascension.	Observed daily motion in R. A.	Computed daily motion in R. A.	Diff. of the observed and comp^{d}.
		h. m. s.	m. s.	m. s.	s.
January	15	19 47 13.042	4 17.523	4 17.500	+ 0.023
	16	19 51 30.565			
February	23	22 24 59.537	3 48.100	3 47.900	+ 0.200
	24	22 28 47.637			
	28	22 43 52.682	3 44.705	3 44.900	— 0.195
March	1	22 47 37.387			
April	30	2 28 32.973	3 48.390	3 48.400	— 0.010
May	1	2 32 21.363			
	31	4 30 53.633	4 4.955	4 5.100	— 0.145
June	1	4 34 58.588			
	—	4 34 58.588	4 5.401	4 5.400	+ 0.001
	2	4 39 3.989			
	—	4 39 3.989	4 5.947	4 5.900	+ 0.047
	3	4 43 9.936			
	—	4 43 9.936	4 6.031	4 6.200	— 0.169
	4	4 47 15.967			
	6	4 55 29.590	4 7.078	4 7.300	— 0.222
	7	4 59 36.668			
August	1	8 44 8.529	3 53.042	3 52.900	+ 0.142
	2	8 48 1.571			
	—	8 48 1.571	3 52.224	3 52.300	— 0.076
	3	8 51 53.795			
	—	8 51 53.795	3 51.761	3 51.800	— 0.039
	4	8 55 45.556			
	8	9 11 6.692	3 48.830	3 48.800	+ 0.030
	9	9 14 55.522			
	17	9 45 6.422	3 44.078	3 44.000	+ 0.078
	18	9 48 50.500			
	—	9 48 50.500	3 43.320	3 43.500	— 0.180
	19	9 52 33.820			
November	13	15 12 33.205	4 5.690	4 5.600	+ 0.090
	14	15 16 38.895			
December	6	16 49 59.310	4 22.282	4 22.300	— 0.018
	7	16 54 21.592			
	—	16 54 21.592	4 22.770	4 22.900	— 0.130
	8	16 58 44.362			
	22	18 0 41.032	4 26.594	4 26.600	— 0.006
	23	18 5 7.626			

Mean = — 0.030

Table III.

To reduce the Sun's Right Ascension, computed for the meridian of Greenwich, to the meridian of Blackman-street.

1821.

		Sun's R. A. computed for the meridian of Greenwich.	Computed daily motion in R. A.	Correction for diff. of long.	Sun's R. A. computed for the meridian of Blackman-street Observatory.
		h. m. s.	m. s.	sec.	h. m. s.
June	30	6 36 3.500	4 8.5	+ 0.063	6 36 3.563
July	9	7 13 8.400	4 5.3	0.062	7 13 8.462
	12	7 25 23.000	4 4.0	0.062	7 25 23.062
	18	7 49 39.500	4 1.0	0.061	7 49 39.561
	19	7 53 40.500	4 0.5	0.061	7 53 40.561
August	3	8 52 48.200	3 51.7	0.059	8 52 48.259
	4	8 56 39.900	3 51.1	0.059	8 56 39.959
	10	9 19 37.300	3 47.4	0.058	9 19 37.358
	11	9 23 24.700	3 46.9	0.058	9 23 24.758
	17	9 45 57.900	3 43.7	0.057	9 45 57.957
	20	9 57 7.600	3 42.4	0.057	9 57 7.657
	21	10 0 50.000	3 41.9	0.057	10 0 50.057
	22	10 4 31.900	3 41.4	0.056	10 4 31.956
	23	10 8 13.300	3 41.1	0.056	10 8 13.356
	24	10 11 54.400	3 40.6	0.056	10 11 54.456
September	2	10 44 46.600	3 37.4	0.055	10 44 46.655
	3	10 48 24.000	3 37.2	0.055	10 48 24.055
	4	10 52 1.200	3 36.9	0.055	10 52 1.255
	5	10 55 38.100	3 36.7	0.055	10 55 38.155
	12	11 20 50.600	3 35.5	0.055	11 20 50.655
	15	11 31 36.900	3 35.4	0.055	11 31 36.955
	16	11 35 12.300	3 35.4	0.055	11 35 12.355
	24	12 3 57.100	3 36.1	0.055	12 3 57.155
	25	12 7 33.200	3 36.3	0.055	12 7 33.255
October	2	12 32 51.600	3 38.0	0.056	12 32 51.656
	21	13 43 6.500	3 47.6	0.058	13 43 6.558
	22	13 46 54.100	3 48.1	0.058	13 46 54.158
	29	14 13 46.700	3 53.3	0.059	14 13 46.759
	30	14 17 40.000	3 54.1	0 060	14 17 40.060
November	6	14 45 15.200	3 59 7	0.061	14 45 15.261
December	2	16 33 38.000	4 20.2	0.066	16 33 38.066
	4	16 42 19.000	4 21.4	0.067	16 42 19.067
	5	16 46 40.400	4 21.8	0.067	16 46 40.467
	6	16 51 2.200	4 22.4	0.067	16 51 2.267
	8	16 59 47.500	4 23.3	0.067	16 59 47.567
	11	17 12 58.800	4 24.5	+ 0.067	17 12 58.867

Note. In computing these corrections, it seems, that I used 22 seconds, in lieu of 21.76, as the longitude of my observatory; the consequence is immaterial.

Sloane Street, July 22d, 1826.

Table IV.

To reduce the Sun's Right Ascension, computed for the meridian of Greenwich, to the meridian of Blackman-street.

1822.

		Sun's R. A. computed for the meridian of Greenwich.	Computed daily motion in R. A.	Correction for diff. of long.	Sun's R. A. computed for the meridian of Blackman-street Observatory.
		h. m. s.	m. s.	s.	h. m. s.
January	15	19 47 12.500	4 17.5	+ 0.066	19 47 12.566
	16	19 51 30.000	4 16.9	0.065	19 51 30.065
February	21	22 17 21.500	3 49.1	0.058	22 17 21.558
	23	22 24 59.100	3 47.9	0.058	22 24 59.158
	24	22 28 47.000	3 47.2	0.058	22 28 47.058
	28	22 43 52.400	3 44.9	0.057	22 43 52.457
March	1	22 47 37.300	3 44.3	0.057	22 47 37.357
April	30	2 28 32.200	3 48.4	0.058	2 28 32.258
May	1	2 32 20.600	3 48.8	0.058	2 32 20.658
	21	3 50 26.700	4 0.3	0.061	3 50 26.761
	22	3 54 27.100	4 0.9	0.061	3 54 27.161
	24	4 2 29.500	4 1.9	0.062	4 2 29.562
	27	4 14 36.600	4 3.4	0.062	4 14 36.662
	31	4 30 52.600	4 5.1	0.062	4 30 52.662
June	1	4 34 57.700	4 5.4	0.062	4 34 57.762
	2	4 39 3.100	4 5.9	0.063	4 39 3.163
	3	4 43 9.000	4 6.2	0.063	4 43 9.063
	4	4 47 15.200	4 6.5	0.063	4 47 15.263
	6	4 55 28.600	4 7.3	0.063	4 55 28.663
	7	4 59 35.900	4 7.5	0.063	4 59 35.963
	22	6 1 50.900	4 9.6	0.064	6 1 50.964
July	4	6 51 36.200	4 7.2	0.063	6 51 36.263
	7	7 3 56.800	4 6.3	0.063	7 3 56.863
	10	7 16 14.400	4 5.1	0.062	7 16 14.462
	31	8 40 14.200	3 53.6	0.059	8 40 14.259
August	1	8 44 7.800	3 52.9	0.059	8 44 7.859
	2	8 48 0.700	3 52.3	0.059	8 49 0.759
	3	8 51 53.000	3 51.8	0.059	8 51 53.059
	4	8 55 44.800	3 51.1	0.059	8 55 44.859
	8	9 11 5.800	3 48.8	0.058	9 11 5.858
	9	9 14 54.600	3 48.3	0.058	9 14 54.658
	17	9 45 5.700	3 44.0	0.057	9 45 5.757
	18	9 48 49.700	3 43.5	0.057	9 48 49.757
	19	9 52 33.200	3 43.0	0.057	9 52 33.257
	21	9 59 58.700	3 42.0	0.057	9 59 58.757
October	14	13 15 59.700	3 43.1	0.057	13 15 59.757
November	4	14 36 21.200	3 57.8	0.061	14 36 21.261
	9	14 56 19.000	4 2.1	0.062	14 56 19.062
	13	15 12 32.800	4 5.6	0.063	15 12 32.863
	14	15 16 38.400	4 6.4	0.063	15 16 38.463
	26	16 6 49.100	4 15.9	0.065	16 6 49.165
	29	16 19 38.900	4 18.1	0.066	16 19 38.966
December	6	16 49 58.700	4 22.3	0.067	16 49 58.767
	7	16 54 21.000	4 22.9	0 067	16 54 21.067
	8	16 58 43.900	4 23.4	0.067	16 58 43.967
	22	18 0 40.800	4 26.6	0.068	17 0 40.868
	23	18 5 7.400	4 26.6	0.068	18 5 7.468
	26	18 18 26.900	4 26.3	0.068	18 18 26.968
	28	18 27 19.400	4 25.9	0.068	18 27 19.468
	30	18 36 11.000	4 25.6	+ 0.068	18 36 11.068

Table V.

To show the difference between the Sun's observed and computed Right Ascensions; (by Blackman-street observations).

1821.

		Sun's R. A. observed when on the meridian of Blackman-street Observatory.	Sun's R. A. computed for the meridian of Blackman-street Observatory.	Diff. of the observed and comp. R. A.	
		h. m. s.	h. m. s.	s	
June	30	6 36 4.397	6 36 3.563	+ 0.834	During these observations, the instrument was defended from the sun's rays, till his first limb had nearly reached, the first wire.
July	9	7 13 9.388	7 13 8.462	0.926	
	12	7 25 23.867	7 25 23.062	0.805	
	18	7 49 40.623	7 49 39.561	1.062	
	19	7 53 41.539	7 53 40.561	0.978	
August	3	8 52 49.015	8 52 48.259	0.756	
	4	8 56 40.613	8 56 39.959	0.654	
	10	9 19 38.255	9 19 37.358	0.897	
	11	9 23 25.529	9 23 24.758	0.771	
	17	9 45 58.551	9 45 57.957	0.594	
	20	9 57 8.647	9 57 7.657	0.990	
	21	10 0 50.790	10 0 50.057	0.733	
	22	10 4 32.711	10 4 31.956	0.755	exposed
	23	10 8 14.109	10 8 13.356	0.753	exposed
	24	10 11 55.135	10 11 54.456	0.679	exposed
September	2	10 44 47.316	10 44 46.655	0.661	defended
	3	10 48 24.727	10 48 24.055	0.672	exposed
	4	10 52 1.916	10 52 1.255	0.661	defended
	5	10 55 38.815	10 55 38.155	0 660	exposed
	12	11 20 51.458	11 20 50.655	0.803	defended
	15	11 31 37.636	11 31 36.955	0.681	defended
	16	11 35 13.163	11 35 12.355	0.808	defended
	24	12 3 57.928	12 3 57.155	0.773	defended
	25	12 7 33.956	12 7 33.255	0.701	exposed
October	2	12 32 52.451	12 32 51.656	0.795	defended
	21	13 43 7.287	13 43 6.558	0.729	exposed
	22	13 46 54.798	13 46 54.158	0.640	exposed
	29	14 13 47.288	14 13 46.759	0.529	defended
	30	14 17 40.668	14 17 40.060	0.608	defended
November	6	14 45 15.827	14 45 15.261	0.566	defended
December	2	16 33 38.642	16 33 38.066	0.576	defended
	4	16 42 19.690	16 42 19.067	0.623	defended
	5	16 46 40.890	16 46 40.467	0.423	defended
	6	16 51 2.831	16 51 2.267	0.564	defended
	8	16 59 48.020	16 59 47.567	0.453	defended
	11	17 12 59.370	17 12 58.867	+ 0.503	defended

Mean by 36 obs, = + 0.712

Note; wherever the word "defended" is annexed to the column of differences, in this, and the following tables, it means, that every part of the instrument, except the object-glass, was entirely excluded from the sun's rays, during the day of observation; as were also the side plates and stone piers.

Table VI.

To show the Differences between the Sun's observed and computed Right Ascensions; (by Blackman-street observations).

1822.

		Sun's R. A. when obsd on the meridian of the Blackman-st. Observy.	Sun's R. A. computed for the meridian of Blackman-street.	Diff. of the observed and computed R. A.	
		h. m. s.	h. m. s.	s.	
January	15	19 47 13.042	19 47 12.566	+ 0.476	defended
	16	19 51 30.565	19 51 30.065	0.500	defended
February	21	22 17 22.161	22 17 21.558	0.603	defended
	23	22 24 59.537	22 24 59.158	0.379	defended
	24	22 28 47.637	22 28 47.058	0.579	defended
	28	22 43 52.682	22 43 52.457	0.225	defended
March	1	22 47 37.387	22 47 37.357	0.030	exposed
April	30	2 28 32.973	2 28 32.258	0.715	defended
May	1	2 32 21.363	2 32 20.658	0.705	defended
	21	3 50 27.622	3 50 26.761	0.861	exposed
	22	3 54 28.093	3 54 27.161	0.932	defended
	24	4 2 30.159	4 2 29.562	0.597	defended
	27	4 14 37.645	4 14 36.662	0.983	defended
	31	4 30 53.633	4 30 52.662	0.971	exposed
June	1	4 34 58.588	4 34 57.762	0.826	defended
	2	4 39 3.989	4 39 3.163	0.826	exposed
	3	4 43 9.936	4 43 9.063	0.873	defended
	4	4 47 15.967	4 47 15.263	0.704	exposed
	6	4 55 29.590	4 55 28.663	0.927	defended
	7	4 59 36.668	4 59 35.963	0.705	exposed
	22	6 1 51.658	6 1 50.964	0.694	exposed
July	4	6 51 37.142	6 51 36 263	0.879	defended
	7	7 3 57.958	7 3 56.863	1.095	defended
	10	7 16 15.436	7 16 14.462	0.974	defended
	31	8 40 15.148	8 40 14.259	0.889	defended
August	1	8 44 8.529	8 44 7.859	0.670	defended
	2	8 48 1.571	8 48 0.759	0.812	defended
	3	8 51 53.795	8 51 53.059	0.736	defended
	4	8 55 45.556	8 55 44.859	0.697	defended
	8	9 11 6.692	9 11 5.858	0.834	defended
	9	9 14 55.522	9 14 54.658	0.864	defended
	17	9 45 6.422	9 45 5.757	0.665	defended
	18	9 48 50.500	9 48 49.757	0.743	defended
	19	9 52 33.820	9 52 33.257	0.563	defended
	21	9 59 59.333	9 59 58.757	0.576	defended
October	14	13 16 0.390	13 16 59.757	0.633	defended
November	4	14 36 21.691	14 36 21.261	0.430	defended
	9	14 56 19.429	14 56 19.062	0.367	defended
	13	15 12 33.205	15 12 32.863	0.342	defended
	14	15 16 38.895	15 16 38.463	0.432	defended
	26	16 6 49.470	16 6 49.165	0.305	defended
	29	16 19 39.433	16 19 38.966	0.467	defended
December	6	16 49 59.310	16 49 58.767	0.543	defended
	7	16 54 21.592	16 54 21.067	0.525	defended
	8	16 58 44.362	16 58 43.967	0.395	defended
	22	18 0 41.032	18 0 40.868	0.164	exposed
	23	18 5 7.626	18 5 7.468	0.158	defended
	26	18 18 27.340	18 18 26.968	0.372	defended
	28	18 27 19.747	18 27 19.468	0.279	defended
	30	18 36 11.560	18 36 11.068	+ 0.492	defended

Mean by 50 obs. = + 0.620

Table VII.

To show the nature and extent of the exposure, to which the Instrument was subjected.

1821.

Exposure of the Instrument, August 22.

The Sun's rays were allowed to fall upon the Instrument, eighteen minutes before his centre came to the meridian; not a cloud intervened, during the interval of exposure; no thermometers were appealed to.

Exposure of the Instrument, August 23.

Times of Comparison. h. m.	Thermometers on the Western Axis.	Thermometers on the Eastern Axis.
9 46	69°.0	69°.0
9 54	83 .9	70 .3
9 57	85 .0	71 .0
10 0	85 .6	71 .0
10 5	85 .6	71 .2
10 10	88 .0	72 .0
	Mean = 85 .6	Mean = 71 .1

Hence, difference of temperature = 14°.5.

Exposure of the Instrument, August 24.

Times of Comparison. h. m.	Thermometers on the Western Axis.	Thermometers on the Eastern Axis.
9 8	70°.0	70°.1
9 18	79 .2	71 .8
9 24	83 .0	71 .8
9 29	84 .5	71 .9
9 33	85 .0	71 .9
9 38	85 .9	71 .9
	Mean = 83 .5	Mean = 71 .9

Hence, difference of temperature = 11°.6.

Table VII.—*continued.*

The bulbs of the thermometers, were now placed under the covers* of each axis and brace, and the results were as follow.

Times of Comparison h. m	Thermometers on the Western Axis.	Thermometers on the Eastern Axis.
9 57	88°.0	72°.0
10 1	90 .0	72 .1
10 6	93 .0	72 .3
10 13	95 .8	72 .5
	Mean = 91 .7	Mean = 72 .2

Hence, difference of temperature = 19°.5.

Thermometers under the covers of the braces, afforded results nearly the same as the above. Not a cloud passed over the sun, during the experiments.

Exposure of the Instrument, September 3.

Times of Comparison. h. m.	Thermometer on the Western Axis.	Thermometer on the Eastern Axis.
10 33	80°.0	69°8.
10 36	83 .2	70 .4
10 39	84 .6	71 .0
10 42	84 .8	72 .1
	Mean = 83 .1	Mean = 70 .8

Hence, difference of temperature = 13°.7.

Note.—The instrument during this day's experiments, was deprived of all its coverings. The exposure commenced at 9^h 43′ sidereal time, but no comparison of the thermometers was made, until 10^h 33′.

Exposure of the Instrument, September 5.

To procure more decisive differences of temperature, between the western brace and axis, and those on the eastern side of the instrument, the former, were now enveloped in black woollen cloth, the latter, in white; the western half also of the centre piece, was covered with *black*, whilst the eastern half of it was enclosed, in *white* cloth; the telescope tubes, however,

* Vide page 434.

Table VII.—*continued.*

were still included in their ordinary coverings, of green cloth.* These arrangements were persevered in, during all future observations; the different portions were well fitted to the figure of the instrument, and not being unseemly, were constantly retained in situ.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
9 45	68°.0	68°.0
10 1	78 .0	69 .8
10 7	81 .8	70 .3
10 10	82 .2	70 .6
10 13	84 .5	70 .8
10 21	84 .0	70 .8
10 30	85 .5	71 .5
10 35	84 .0	71 .8
10 38	84 .0	71 .8
10 45	87 .0	72 .2
10 49	89 .0	72 .5
10 51	90 .0	72 .4
	Mean = 84 .5	Mean = 71 .3

Hence, difference of temperature = 13°.2.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Brace.	Thermometers under the cover of the White, or Eastern Brace.
9 45	68°.0	68°.0
10 23	84 .0	71 .0
10 25	84 .5	72 .0
10 30	85 .5	72 .0
10 35	85 .5	72 .0
10 40	86 .0	71 .0
10 45	86 .0	73 .0
10 49	88 .0	73 .0
10 51	89 .5	73 .0
	Mean = 86 .1	Mean = 72 .1

Hence, difference of temperature = 14°.0.

During these experiments not a cloud had been visible.

* Vide page 434.

Table VII.—*continued.*

Exposure of the Instrument, September 25.

The Sun's rays were allowed to fall upon the instrument, sixty-three minutes before his centre came to the meridian; other observations prevented me, attending to the thermometers; the sky cloudless.

Exposure of the Instrument, October 21.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
12 56	50°.0	50°.0
13 9	59 .0	51 .5
13 10	60 .5	51 .5
13 12	62 .0	51 .7
13 19	65 .0	52 .0
13 23	67 .0	52 .2
13 27	69 .0	52 .5
13 45	70 .0	53 .5
	Mean = 64 .6	Mean = 52 .1

Hence, difference of temperature = 12°.5.

Thermometers placed under the covers of the black and white braces, did not vary half a degree, from those applied to the cones of the axis. During the observations, not a cloud was visible.

Exposure of the Instrument, October 22.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
12 56	51°.0.	51°.0
13 6	64 .0	52 .5
13 12	65 .0	53 .0
13 18	67 .0	53 .5
13 20	68 .5	53 .8
13 22	71 .0	54 .0
13 24	73 .8	54 .0
13 26	74 .5	54 .1
13 46	76 .0	54 .8
	Mean = 70 .0	Mean = 53 .7

Hence, difference of temperature = 16°.3.

Thermometers under the covers of the black, and white braces, afforded results differing from the above, only a small fraction of a degree.

Table VII.—*continued.*

1822.

Exposure of the Instrument, March 1.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
21 33	41°.0	41°.0
22 10	58 .0	44 .0
22 27	68 .5	44 .5
22 40	68 .0	44 .5
22 49	68 .5	45 .5
	Mean = 65 .8	Mean = 44 .6

Hence, difference of temperature = 21°.2.

Not a cloud was visible, from the time at which the shutter was opened, until the experiments were concluded.

Exposure of the Instrument, May 21.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Brace.	Thermometers under the cover of the White, or Eastern Brace.
2 47	66°.3	66°.3
3 22	89 .0	72 .0
3 45	91 .0	74 .0
3 53	94 .0	74 .0
	Mean = 91 .3	Mean = 73 .3

Hence, difference of temperature = 18°.0.

Thermometers under the covers of the western and eastern axes, gave results similar to these. Sky cloudless.

Exposure of the Instrument, May 31.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
3 20	60°.0	60°.0
3 55	80 .0	62 .0
4 10	84 .0	63 .0
4 20	86 .0	63 .0
4 33	90 .0	64 .0
	Mean = 85 .0	Mean = 63 .0

Hence, difference of temperature = 22°.0.

A cloudless sky, during the observations. Thermometers under the covers of the braces, gave results coincident with the above.

Table VII.—*continued.*

Exposure of the Instrument, June 2.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
3 30	67°.5	67°.8
4 0	80 .0	70 .0
4 5	86 .0	71 .0
4 15	95 .0	73 .0
4 28	96 .0	74 .0
4 34	98 .0	74 .5
4 42	100 .5	75 .0
	Mean = 92 .6	Mean = 72 .9

Hence, difference of temperature = 19°.7.

Thermometers under the covers of the braces, afforded results similar with the above. Not a cloud passed over the Sun, during the time the instrument was exposed to his rays. Thermometers placed *immediately over* the black axis, never indicated a temperature exceeding 94°.

Exposure of the Instrument, June 4.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
3 50	68°.5	68°.3
4 25	96 .0	71 .0
4 35	98 .0	72 .0
4 40	100 .0	74 .0
4 45	104 .0	76 .0
4 50	107 .0	76 .0
	Mean = 101 .0	Mean = 73 .8

Hence, difference of temperature = 27°.2.

Thermometers placed under the covers of the braces, do not differ one degree from the above. A cloudless sky.

Table VII.—*continued.*

Exposure of the Instrument, June 7.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Brace.	Thermometers under the cover of the White, or Eastern Brace.
3 50	62°.0	62°.0
4 20	90 .0	64 .0
4 30	96 .0	65 .0
4 50	100 .0	68 .0
5 2	108 .0	74 .0
	Mean = 98 .5	Mean = 67 .8

Hence, difference of temperature = 30°.7.

Not a cloud visible, during the exposure of the instrument. Thermometers under the covers of the axis, gave results similar to the above.

Exposure of the Instrument, June 22.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
5 0	61°.3	61°.5
5 20	88 .0	64 .0
5 30	90 .0	64 .0
5 45	92 .0	66 .0
5 53	94 .0	68 .0
6 4	98 .0	71 .0
	Mean = 92 .4	Mean = 66 .6

Hence, difference of temperature = 25°.8.

Exposure of the Instrument, December 22.

The Sun's rays, were allowed to fall upon the instrument, half an hour before noon, at which time, the thermometers on the western and eastern axes, stood at 53°.0 and 31°.0.

Hence, difference of temperature = 22°.0.

Table VIII.

To show the Transits of the Pole Star, and the nature of the exposure to which the Instrument was subjected.

1821.

Observed Transits of the Pole Star.

	m. s. A	m. s. B	h. m. s. C	m. s. D	m. s. E	
October 20	28 40.0	43 1.5	0 57 20.0	11 39.5	26 1.5	Polaris.
	E	D	C	B	A	
21	28 38.0	43 0.0	12 57 19.0	11 35.0	25 55.0	Polaris *sp.* (trems.)
	E	D	C	B	A	
22	28 34.0	42 58.5	12 57 17.5	11 35.5	25 55.0	Polaris *sp.*
	A	B	C	D	E	
22	28 42.0	43 3.0	0 57 20.5	11 38.0	26 2.0	Polaris.
	E	D	C	B	A	
24	28 34.5	42 55.0	12 57 14.0	11 29.5	.....	Polaris *sp.*

On the 21st and 22nd, the Sun's rays were allowed to fall upon the instrument, immediately after the star, at its *sub* polar transit, had passed the wire C, until its transits over the wires B and A, were procured.

With these exceptions, the instrument was entirely defended, from the influence of the solar rays.

Exposure of the Instrument, October 21.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
12 56	50°.0	50°.0
13 9	59 .0	51 .5
13 10	60 .5	51 .5
13 12	62 .0	51 .7
13 19	65 .0	52 .0
13 23	67 .0	52 .2
13 26.30	69 .0	52 .5
	Mean = 63 .7	Mean = 51 .9

Hence, difference of temperature = 11°.8.

Thermometers placed under the covers of the black and white braces, did not differ with those applied to the axes, half a degree.

During the observations not a cloud visible.

Table VIII.—*continued.*

Exposure of the Instrument, October 22.

Times of Comparison.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
h. m.	°	°
12 56	51 .0	51 .0
13 6	64 .0	52 .5
13 12	65 .0	53 .0
13 18	67 .0	53 .5
13 20	68 .5	53 .8
13 22	71 .0	54 .0
13 24	73 .8	54 .0
13 26	74 .5	54 .1
	Mean = 69 .1	Mean = 53 .6

Hence, difference of temperature = 15°.5.

Thermometers placed under the covers of the black and white braces, gave results similar to these. An Italian sky; not a cloud to be seen.

1823.

Observed Transits of the Pole Star.

	m. s.	m. s.	h. m. s.	m. s.	m. s.	
		D	C			
October 9	.....	44 11.0	12 58 39.0	.....	.....	Polaris *sp.*
		D	C			
10	.....	44 14.5	12 58 38.0	.....	.....	Polaris *sp.*
		D	C			
11	.....	44 15.0	12 58 38.0	.....	.....	Polaris *sp.*
	A	B	C	D	E	
11	29 55.5	44 21.5	0 58 46.0	13 11.0	27 38.0	Polaris.
	E			B		
12	29 43.5	.....	.....	12 59.5	.....	Polaris *sp.*
	A	B	C	D	E	
13	29 56.0	44 21.0	0 58 46.0	13 13.0	27 40.5	Polaris.
	A	B	C	D	E	
15	29 53.0	44 23.0	0 58 47.0	13 10.0	27 38.0	Polaris.
	E	D	C			
16	29 45.0	44 13.0	12 58 38.5	.....	.....	Polaris *sp.*
	A	B	C	D		
*16	29 56.0	44 23.0	0 58 44.5	13 12.0	.....	Polaris.

On the 9th and 10th, the Sun's rays were allowed to fall upon the instrument, after the star at its *sub*-polar transit, had passed the wire D.

On the 12th and 16th, the instrument was exposed to the Sun, after that the star at its *sub*-polar transit, had traversed the wire E.

With these exceptions, the instrument was *entirely defended*, from the Sun's rays.

* These observations (the clock's daily rate being nearly insensible), indicate slight *ex*-meridian position; and may serve as a practical illustration, of the statement made in page 432; seeing, that *seven* months have elapsed, since the instrument was moved by its azimuthal adjustment; and that nearly *seventeen* have transpired, since non-horizontality of its axis, could be detected.

Table VIII.—*continued.*

Exposure of the Instrument, October 9.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
12 43	54°.0	54°.0
12 49	69 .0	54 .7
12 51	73 .0	54 .8
12 53	75 .0	55 .0
12 55	76 .0	55 .2
12 57	76 .5	55 .8
12 59	78 .0	56 .0
	Mean = 74 .6	Mean = 55 .3

Hence, difference of temperature = 19°.3.

Thermometers placed under the covers of the black and white braces, did not vary from those applied to the axes, more than half, or three-quarters of a degree. During the observations not a cloud had been visible.

Exposure of the Instrument, October 10.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
12 42	50°.0	50°.0
12 49	68 .0	51 .0
12 52	75 .0	52 .0
12 53	78 .0	52 .3
12 55	79 .0	52 .5
12 57	81 .0	53 .0
12 59	83 .0	53 .5
	Mean = 77 .3	Mean = 52 .4

Hence, difference of temperature = 24°.9.

Not a cloud visible, during the observations. Thermometers under the covers of the western and eastern braces, did not differ more than half a degree, from those applied to the axes.

Table VIII.—*continued.*

Exposure of the Instrument, October 12.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
12 28	50°.0	50°.0
12 40	68 .0	51 .5
12 50	70 .0	51 .7
12 53	73 .0	51 .8
12 57	74 .0	52 .2
13 5	74 .5	52 .5
13 10	75 .2	53 .0
13 12	75 .4	53 .2
	Mean = 72 .9	Mean = 52 .3

Hence, difference of temperature = 20°.6.

Thermometers under the covers of the western and eastern braces, did not differ from those applied to the axes, one degree.

Light clouds passing, prevented the transits over the wires D and C, being procured; and it was not deemed right to call in the aid of the micrometer wire, lest any source of error, might be suspected. Not a cloud, however, was visible, south of the zenith of the observatory during the experiments. The transits over E and B, were extremely satisfactory, the star being remarkably steady.

Exposure of the Instrument, October 16.

Times of Comparison. h. m.	Thermometers under the cover of the Black, or Western Axis.	Thermometers under the cover of the White, or Eastern Axis.
12 28	49°.0	49°.0
12 34	64 .5	50 .0
12 38	66 .5	51 .5
12 42	69 .0	51 .7
12 45	70 .0	52 .0
12 49	71 .0	52 .6
12 55	72 .5	53 .0
12 59	73 .8	53 .3
	Mean = 69 .6	Mean = 52 .0

Hence, difference of temperature = 17°.6.

Thermometers under the covers of the braces, gave results not differing from the above, one degree. Not a cloud visible, during the observations.

Table IX.

Showing the time, in which the Pole Star passed to the several wires of the Instrument, under experiments of exposure.

1821.

	min.	sec.
October 21. From C to B	14	16. 0
22	14	18. 0
Mean =	14	17. 0
October 21. From B to A	14	20. 0
22	14	20. 5
Mean =	14	20.25
October 21. From B to E	42	57. 0
22	43	1. 5
Mean =	42	59.25

	min.	sec.
October 21. From C to A	28	36. 0
22	28	37. 5
Mean =	28	36.75
October 21. From B to D	28	35. 0
22	28	37. 0
Mean =	28	36. 0
October 21. From A to D	42	55. 0
22	42	56. 5
Mean =	42	55.75

	min.	sec.
October 21. From A to E	57	17.0
22	57	21.0
Mean =	57	19.0

1823.

	min.	sec.
October 9. From C to D	14	28. 0
10	14	23. 5
16	14	25. 5
Mean =	14	25.67
October 16. From E to D	14	28. 0

	min.	sec.
October 12. From B to E	43	16.0
October 16. From E to C	28	53.5

Table X.

Showing the times in which the Pole Star passed to the several wires, when the Instrument was defended from the Sun's rays.

1821.

	min.	sec.
October 20. From C to B	14	18. 5
22	14	17. 5
24	14	15. 5
Mean =	14	17.17
October 20. From B to A	14	21. 5
22	14	21. 0
Mean =	14	21.25
October 20. From B to E	43	0. 0
22	42	59. 0
24	42	55. 0
Mean =	42	58. 0
October 20. From A to E	57	21. 5
22	57	20. 0
Mean =	57	20.75
October 20. From C to A	28	40. 0
22	28	38. 5
Mean =	28	39.25
October 20. From B to D	28	38. 0
22	28	35. 0
24	28	34. 5
Mean =	28	35.83
October 20. From A to D	42	59. 5
22	42	56. 0
Mean =	42	57.75

1823.

	min.	sec.
October 11. From C to D	14	23. 0
11	14	25. 0
13	14	27. 0
15	14	23. 0
16	14	27. 5
Mean =	14	25.10
October 11. From E to D	14	27. 0
13	14	27. 5
15	14	28. 0
Mean =	14	27.50
October 11. From B to E	43	16. 5
13	43	19. 5
15	43	15. 0
Mean =	43	17.00
October 11. From E to C	28	52. 0
13	28	54. 5
15	28	51. 0
Mean =	28	52.50

Table XI.

Showing the differences between the intervals of time, in which the Pole Star passed to the several wires, when the instrument was exposed to, and defended from, the Sun's rays.

1821.	min.	sec.	Difference. sec.
C B (1 interval); 1 exposed =	14	17.00	— 0.17
C B defended ..... =	14	17.17	
C A (2 intervals); 2 exposed =	28	36.75	— 2.50
C A defended ..... =	28	39.25	
B A (1 interval); 1 exposed =	14	20.25	— 1.00
B A defended ..... =	14	21.25	
B D (2 intervals); 1 exposed =	28	36.00	+ 0.17
B D defended ..... =	28	35.83	
B E (3 intervals); 1 exposed =	42	59.25	+ 1.25
B E defended ..... =	42	58.00	
A D (3 intervals); 2 exposed =	42	55.75	— 2.00
A D defended ..... =	42	57.75	
A E (4 intervals); 2 exposed =	57	19.00	— 1.75
A E defended ..... =	57	20.75	

1823.	min.	sec.	Difference. sec.
C D (1 interval); 1 exposed =	14	25.67	+ 0.57
C D defended ..... =	14	25.10	
B E (3 intervals); 3 exposed =	43	16.00	— 1.00
B E defended ..... =	43	17.00	
E D (1 interval); 1 exposed =	14	28.00	+ 0.50
E D defended ..... =	14	27.50	
E C (2 intervals); 2 exposed =	28	53.50	+ 1.00
E C defended ..... =	28	52.50	

Table XII.

To reduce the Sun's Right Ascension, computed for the meridian of Greenwich, to the meridian of Paris.

1821.

	Sun's R. A. computed for the meridian of Greenwich.	Computed daily motion in R. A.	Correction for Diff. of Longit.	Sun's R. A. computed for the meridian of Paris.
	h. m. s.	m. s.	s.	h. m. s.
July 18	7 49 39.500	4 1.0	— 1.565	7 49 37.935
19	7 53 40.500	4 0.5	1.562	7 53 38.938
August 20	9 57 7.600	3 42.4	1.444	9 57 6.156
21	10 0 50.000	3 41.9	1.441	10 0 48.559
22	10 4 31.900	3 41.4	1.438	10 4 30.462
23	10 8 13.300	3 41.1	1.436	10 8 11.864
24	10 11 54.400	3 40.6	1.432	10 11 52.968
September 2	10 44 46.600	3 37.4	1.412	10 44 45.188
4	10 52 1.200	3 36.9	1.408	10 51 59.792
5	10 55 38.100	3 36.7	1.407	10 55 36.693
October 2	12 32 51.600	3 38.0	1.415	12 32 50.185
21	13 43 6.500	3 47.6	1.478	13 43 5.022
29	14 13 46.700	3 53.3	1.515	14 13 45.185
30	14 17 40.000	3 54.1	1.520	14 17 38.480
November 6	14 45 15.200	3 59.7	1.556	14 45 13.644
December 4	16 42 19.000	4 21.4	— 1.697	16 42 17.303

Table XIII.

To reduce the Sun's Right Ascension, computed for the meridian of Greenwich, to the meridian of Paris.

1822.

		Sun's R. A. computed for the meridian of Greenwich.	Computed daily motion in R. A.	Correction for Diff. of Longit.	Sun's R. A. computed for the meridian of Paris.
		h. m. s.	m. s.	s.	h. m. s.
January	15	19 47 12.500	4 17.5	— 1.672	19 47 10.828
February	21	22 17 21.500	3 49.1	1.487	22 17 20.013
	23	22 24 59.100	3 47.9	1.480	22 24 57.620
	28	22 43 52.400	3 44.9	1.460	22 43 50.940
March	1	22 47 37.300	3 44.3	1.456	22 47 35.844
April	30	2 28 32.200	3 48.4	1.483	2 28 30.717
May	1	2 32 20.600	3 48.8	1.486	2 32 29.114
	21	3 50 26.700	4 0.3	1.560	3 50 25.140
	22	3 54 27.100	4 0.9	1.564	3 54 25.536
	31	4 30 52.600	4 5.1	1.591	4 30 51.009
June	1	4 34 57.700	4 5.4	1.593	4 34 56.107
	2	4 39 3.100	4 5.9	1.597	4 39 1.503
	3	4 43 9.000	4 6.2	1.599	4 43 7.401
	4	4 47 15.200	4 6.5	1.601	4 47 13.599
	6	4 55 28.600	4 7.3	1.606	4 55 26.994
	7	4 59 35.900	4 7.5	1.607	4 59 34.293
July	4	6 51 36.200	4 7.2	1.605	6 51 34.595
	10	7 16 14.400	4 5.1	1.591	7 16 12.809
August	1	8 44 7.800	3 52.9	1.512	8 44 6.288
	2	8 48 0.700	3 52.3	1.508	8 47 59.192
	17	9 45 5.700	3 44.0	1.454	9 45 4.246
	18	9 48 49.700	3 43.5	1.451	9 48 48.249
November	26	16 6 49.100	4 15.9	1.662	16 6 47.438
December	6	16 49 58.700	4 22.3	1.703	16 49 56.997
	7	16 54 21.000	4 22.9	1.707	16 54 19.293
	22	18 0 40.800	4 26.6	1.731	18 0 39.069
	26	18 18 26.900	4 26.3	1.729	18 18 25.171
	28	18 27 19.400	4 25.9	— 1.727	18 27 17.673

Table XIV.

To reduce the Sun's Right Ascension, computed for the meridian of Greenwich, to the meridian of Dublin Observatory.

1821.

		Sun's R. A. computed for the meridian of Greenwich.	Computed daily motion in R. A.	Correction for Diff. of Longit.	Sun's R. A. computed for the meridian of Dublin Observatory.
		h. m. s.	m. s.	s.	h. m. s.
June	30	6 36 3.500	4 8.5	+ 4.342	6 36 7.842
July	12	7 25 23.000	4 4.0	4.298	7 25 27.298
	19	7 53 40.500	4 0.5	4.237	7 53 44.737
August	23	10 8 13.300	3 41.1	3.895	10 8 17.195
	24	10 11 54.400	3 40.6	3.886	10 11 58.286
October	2	12 32 51.600	3 38.0	3.840	12 32 55.440
	29	14 13 46.700	3 53.3	4.110	14 13 50.810
December	6	16 51 2.200	4 22.4	4.622	16 51 6.822
	11	17 12 58.800	4 24.5	+ 4.659	17 13 3.459

Table XV.

To reduce the Sun's Right Ascension, computed for the meridian of Greenwich, to the meridian of Dublin Observatory.

1822.

		Sun's R. A. computed for the meridian of Greenwich.	Computed daily motion in R. A.	Correction for Diff. of Longit.	Sun's R. A. computed for the meridian of Dublin Observatory.
		h. m. s.	m. s.	s.	h. m. s.
May	1	2 32 20.600	3 48.8	+ 4.030	2 32 24.630
	21	3 50 26.700	4 0.3	4.233	3 50 30.933
	22	3 54 27.100	4 0.9	4.244	3 54 31.344
	24	4 2 29.500	4 1.9	4.261	4 2 33.761
June	1	4 34 57.700	4 5.4	4.323	4 35 2.023
	3	4 43 9.000	4 6.2	4.337	4 43 13.337
	6	4 55 28.600	4 7.3	4.356	4 55 32.956
	7	4 59 35.900	4 7.5	4.360	4 59 40.260
	22	6 1 50.900	4 9.6	4.397	6 1 55.297
August	2	8 48 0.700	3 52.3	4.092	8 48 4.792
	19	9 52 33.200	3 43.0	3.928	9 52 37.128
	21	9 59 58.700	3 42.0	3.911	10 0 2.611
November	14	15 16 38.400	4 6.4	4.340	15 16 42.740
December	7	16 54 21.000	4 22.9	4.631	16 54 25.631
	26	18 18 26.900	4 26.3	+ 4.673	18 18 31.573

Table XVI.

To convert the Sun's observed Right Ascension, reduced by the Paris Catalogue, into his correspondent Right Ascension, by the Greenwich Catalogue.

1821.

	Sun's R. A. observed at Paris, the reductions being made by the Paris Catalogue.	Equation for Diff. of Paris and Greenwich Catal.	Sun's R. A. observed at Paris, reduced by the Greenwich Catalogue.
	h. m. s.	s.	h. m. s.
July 18	7 49 37.950	+0.260	7 49 38.210
19	7 53 39.200	0.270	7 53 39.470
August 20	9 57 6.550	0.280	9 57 6.830
21	10 0 48.620	0.350	10 0 48.970
22	10 4 30.830	0.320	10 4 31.150
23	10 8 12.440	0.340	10 8 12.780
24	10 11 53.530	0.260	10 11 53.790
September 2	10 44 45.750	0.250	10 44 46.000
4	10 52 0.210	0.230	10 52 0.440
5	10 55 37.080	0.280	10 55 37.360
October 2	12 32 50.280	0.320	12 32 50.600
21	13 43 5.600	0.340	13 43 5.940
29	14 13 45.330	0.340	14 13 45.630
30	14 17 38.540	0.270	14 17 38.810
November 6	14 45 13.680	0.330	14 45 14.010
December 4	16 42 17.460	+0.260	16 42 17.720

Table XVII.

To convert the Sun's observed Right Ascension, reduced by the Paris Catalogue, into his correspondent Right Ascension, by the Greenwich Catalogue.

1822.

		Sun's R.A. observed at Paris, the reductions being made by Paris Catalogue.	Equation for Diff. of Paris and Greenwich Catal.	Sun's R.A. observed at Paris, reduced by the Greenwich Catalogue.
		h. m. s.	s.	h. m. s.
January	15	19 47 10.500	+ 0.400	19 47 10.900
February	21	22 17 20.310	0.340	22 17 20.650
	23	22 24 57.710	0.280	22 24 57.990
	28	22 43 51.240	0.310	22 43 51.550
March	1	22 47 35.980	0.300	22 47 36.280
April	30	2 28 30.710	0.180	2 28 30.890
May	1	2 32 19.280	0.300	2 32 19.580
	21	3 50 25.350	0.280	3 50 25.630
	22	3 54 26.230	0.390	3 54 26.620
	31	4 30 51.430	0.370	4 30 51.780
June	1	4 34 56.150	0.190	4 34 56.340
	2	4 39 1.910	0.220	4 39 2.130
	3	4 43 7.950	0.270	4 43 8.220
	4	4 47 14.030	0.200	4 47 14.230
	6	4 55 27.410	0.190	4 55 27.600
	7	4 59 35.070	0.360	4 59 35.430
July	4	6 51 34.850	0.350	6 51 35.200
	10	7 16 13.500	0.390	7 16 13.890
August	1	8 44 6.980	0.280	8 44 6.260
	2	8 47 59.730	0.340	8 48 0.060
	17	9 45 4.300	0.330	9 45 4.630
	18	9 48 48.260	0.340	9 48 48.600
November	26	16 6 47.570	0.280	16 6 47.850
December	6	16 49 57.020	0.360	16 49 57.380
	7	16 54 19.610	0.350	16 54 19.960
	22	18 0 38.910	0.280	18 0 39.190
	26	18 18 25.060	0.270	18 18 25.330
	28	18 27 17.840	+ 0.280	18 27 18.120

Table XVIII.

To convert the Sun's observed Right Ascension, reduced by the Dublin Catalogue, into his correspondent Right Ascension reduced by the Greenwich Catalogue.

1821.

		Sun's R. A. observed at Dublin, the reductions being made by the Dublin Catalogue.	Equation for Diff. of Dublin and Greenwich Cat.	Sun's R. A. observed at Dublin, reduced by the Greenwich Catalogue.
		h. m. s.	s.	h. m. s.
June	30	6 36 8.500	+ 0.281	6 36 8.781
July	12	7 25 27.880	0.282	7 25 28.162
	19	7 53 45.250	0.298	7 53 45.548
August	23	10 8 17.650	0.207	10 8 17.857
	24	10 11 58.860	0.295	11 11 59.155
October	2	12 32 55.590	0.207	12 32 55.797
	29	14 13 51.050	0.261	14 13 51.311
December	6	16 51 7.100	0.291	16 51 7.391
	11	17 13 3.590	+ 0.288	17 13 3.878

Table XIX.

To convert the Sun's observed Right Ascension, reduced by the Dublin Catalogue, into his correspondent Right Ascension, by the Greenwich Catalogue.

1822.

		Sun's R. A. observed at Dublin, the reductions being made by the Dublin Catalogue.	Equation for Diff. of Dublin and Greenwich Cat.	Sun's R. A. observed at Dublin, reduced by the Greenwich Catalogue.
		h. m. s.	s.	h. m. s.
May	1	2 32 25.030	+ 0.272	2 32 25.302
	21	3 50 31.570	0.276	3 50 31.846
	22	3 54 31.920	0.289	3 54 32.209
	24	4 2 34.250	0.288	4 2 34.538
June	1	4 35 2.340	0.313	4 35 2.653
	3	4 43 13.840	0.303	4 43 14.143
	6	4 55 33.660	0.303	4 55 33.963
	7	4 59 40.680	0.307	4 59 40.987
	22	6 1 55.760	0.289	6 1 56.049
August	2	8 48 5.220	0.294	8 48 5.514
	19	9 52 37.390	0.273	9 52 37.663
	21	10 0 2.720	0.263	10 0 2.983
November	14	15 16 42.750	0.291	15 16 43.041
December	7	16 54 25.990	0.299	16 54 26.289
	26	18 18 31.830	+ 0.295	18 18 32.125

Table XX.

To show the Differences between the Sun's observed, and computed Right Ascensions; (by Greenwich observations).

1821.

		Sun's R. A. observed on the meridian of Greenwich.	Sun's R. A. computed for the meridian of Greenwich.	Difference of the observed and computed R. A.
		h. m. s.	h. m. s.	s.
June	30	6 36 4.28	6 36 3.50	+ 0.78
July	9	7 13 9.23	7 13 8.40	0.83
	12	7 25 23.69	7 25 23.00	0.69
	18	7 49 40.27	7 49 39.50	0.77
	19	7 53 41.08	7 53 40.50	0.58
August	3	8 52 48.87	8 52 48.20	0.67
	4	8 56 40.37	8 56 39.90	0.47
	10	9 19 38.07	9 19 37.30	0.77
	11	9 23 25.17	9 23 24.70	0.47
	17	9 45 58.73	9 45 57.90	0.83
	20	9 57 8.26	9 57 7.60	0.66
	21	10 0 50.94	10 0 50.00	0.94
	22	10 4 32.62	10 4 31.90	0.72
	23	10 8 13.75	10 8 13.30	0.45
	24	10 11 54.97	10 11 54.40	0.57
September	2	10 44 47.44	10 44 46.60	0.84
	3	10 48 24.69	10 48 24.00	0.69
	4	10 52 1.85	10 52 1.20	0.65
	5	10 55 38.45	10 55 38.10	0.35
	15	11 31 37.47	11 31 36.90	0.57
October	2	12 32 52.15	12 32 51.60	0.55
	21	13 43 7.39	13 43 6.50	0.89
	22	13 46 54.77	13 46 54.10	0.67
	29	14 13 47.11	14 13 46.70	0.41
	30	14 17 40.64	14 17 40.00	0.64
November	6	14 45 15.81	14 45 15.20	0.61
December	4	16 42 19.61	16 42 19.00	0.61
	5	16 46 40.49	16 46 40.40	0.09
	6	16 51 3.10	16 51 2.20	0.90
	8	16 59 47.87	16 59 47.50	0.37
	11	17 12 59.18	17 12 58.80	+ 0.38

Mean by 31 obs. = + 0.627

Table XXI.

To show the Differences between the Sun's observed, and computed Right Ascensions; (by Greenwich observations).

1822.

		Sun's R. A. observed on the meridian of Greenwich.	Sun's R. A. computed for the meridian of Greenwich.	Difference of the observed and computed R. A.
		h. m. s.	h. m. s.	s.
January	15	19 47 12.68	19 47 12.50	+ 0.18
	16	19 51 30.44	19 51 30.00	0.44
February	21	22 17 21.84	22 17 21.50	0.34
	23	22 24 59.33	22 24 59.10	0.23
	24	22 28 47.00	22 28 47.00	0.00
	28	22 43 52.55	22 43 52.40	+ 0.15
March	1	22 47 37.20	22 47 37.30	— 0.10
April	30	2 28 32.50	2 28 32.20	+ 0.30
May	1	2 32 20.83	2 32 20.60	0.23
	21	3 50 27.49	3 50 26.70	0.79
	22	3 54 27.69	3 54 27.10	0.59
	24	4 2 30.05	4 2 29.50	0.55
	27	4 14 37.27	4 14 36.60	0.67
	31	4 30 52.93	4 30 52.60	0.33
June	1	4 34 58.18	4 34 57.70	0.48
	2	4 39 3.67	4 39 3.10	0.57
	3	4 43 9.43	4 43 9.00	0.43
	4	4 47 15.66	4 47 15.20	0.46
	6	4 55 29.28	4 55 28.60	0.68
	7	4 59 36.22	4 59 35.90	0.32
	22	6 1 51.47	6 1 50.90	0.57
July	7	7 3 57.50	7 3 56.80	0.70
	31	8 40 14.63	8 40 14.20	0.43
August	1	8 44 8.11	8 44 7.80	0.31
	2	8 48 1.27	8 48 0.70	0.57
	3	8 51 53.82	8 51 53.00	0.82
	4	8 55 45.40	8 55 44.80	0.60
	8	9 11 6.22	9 11 5.80	0.42
	17	9 45 6.16	9 45 5.70	0.46
	18	9 48 50.12	9 48 49.70	0.42
	19	9 52 33.35	9 52 33.20	0.15
	21	9 59 59.24	9 59 58.70	0.54
November	4	14 36 21.52	14 36 21.20	0.32
	9	14 56 19.00	14 56 19.00	0.00
	13	15 12 33.11	15 12 32.80	0.31
	14	15 16 38.72	15 16 38.40	0.32
	29	16 19 39.38	16 19 38.90	0.48
December	6	16 49 59.24	16 49 58.70	0.54
	7	16 54 21.47	16 54 21.00	0.47
	8	16 58 44.49	16 58 43.90	0.59
	22	18 0 41.17	18 0 40.80	0.37
	23	18 5 7.68	18 5 7.40	0.28
	26	18 18 27.31	18 18 26.90	0.41
	28	18 27 19.79	18 27 19.40	0.39
	30	18 36 11.80	18 36 11.00	+ 0.80
			Mean by 45 obs. =	+ 0.420

Table XXII.

To show the Differences between the Sun's observed, and computed Right Ascensions. (By Paris Observations.)

1821.

	Sun's R. A. observed at Paris, reduced by the Greenwich Catalogue.	Sun's R. A. computed for the Meridian of Paris.	Difference of the observed and computed R. A.
	h. m. s.	h. m. s.	s.
July 18	7 49 38.210	7 49 37.935	+ 0.275
19	7 53 39.470	7 53 38.938	0.532
August 20	9 57 6.830	9 57 6.156	0.674
21	10 0 48.970	10 0 48.559	0.411
22	10 4 31.150	10 4 30.462	0.688
23	10 8 12.780	10 8 11.864	0.916
24	10 11 53.790	10 11 52.968	0.822
September 2	10 44 46.000	10 44 45.188	0.812
4	10 52 0.440	10 51 59.792	0.648
5	10 55 37.360	10 55 36.693	0.667
October 2	12 32 50.600	12 32 50.185	0.415
21	13 43 5.940	13 43 5.022	0.918
29	14 13 45.630	14 13 45.185	0.445
30	14 17 38.810	14 17 38.480	0.330
November 6	14 45 14.010	14 45 13.644	0.366
December 4	16 42 17.720	16 42 17.303	+ 0.417
		Mean by 16 obs. =	+ 0.584

Table XXIII.

To show the Differences between the Sun's observed, and computed Right Ascensions. (By Paris Observations.)

1822.

		Sun's R. A. observed at Paris, reduced by the Greenwich Catalogue.	Sun's R. A. computed for the Meridian of Paris.	Difference of the observed and computed R. A.
		h. m. s.	h. m. s.	s.
January	15	19 47 10.900	19 47 10.828	+ 0.072
February	21	22 17 20.650	22 17 20.013	0.637
	23	22 24 57.990	22 24 57.620	0.370
	28	22 43 51.550	22 43 50.940	0.610
March	1	22 47 36.280	22 47 35.844	0.436
April	30	2 28 30.890	2 28 30.717	0.173
May	1	2 32 19.580	2 32 19.114	0.466
	21	3 50 25.630	3 50 25.140	0.490
	22	3 54 26.620	3 54 25.536	1.084
	31	4 30 51.780	4 30 51.009	0.771
June	1	4 34 56.340	4 34 56.107	0.233
	2	4 39 2.130	4 39 1.503	0.627
	3	4 43 8.220	4 43 7.401	0.819
	4	4 47 14.230	4 47 13.599	0.631
	6	4 55 27.600	4 55 26.994	0.606
	7	4 59 35.430	4 59 34.293	1.137
July	4	6 51 35.200	6 51 34.595	0.605
	10	7 16 13.890	7 16 12.809	1.081
August	1	8 44 6.260	8 44 6.288	0.972
	2	8 48 0.060	8 47 59.192	0.868
	17	9 45 4.630	9 45 4.246	0.384
	18	9 48 48.600	9 48 48.249	0.351
November	26	16 6 47.850	16 6 47.438	0.412
December	6	16 49 57.380	16 49 56.997	0.383
	7	16 54 19.960	16 54 19.293	0.667
	22	18 0 39.190	18 0 39.069	0.121
	26	18 18 25.330	18 18 25.171	0.159
	28	18 27 18.120	18 27 17.673	+ 0.447
			Mean by 28 obs. =	+ 0.558

Table XXIV.

To show the Differences between the Sun's observed, and computed Right Ascensions; (by Dublin observations.)

1821.

		Sun's R. A. observed at Dublin, reduced by the Greenwich Catalogue.	Sun's R. A. computed for the meridian of Dublin Observatory.	Diff. of the observed and computed R. A.
		h. m. s.	h. m. s.	s.
June	30	6 36 8.781	6 36 7.842	+ 0.939
July	12	7 25 28.162	7 25 27.298	0.864
	19	7 53 45.548	7 53 44.737	0.811
August	23	10 8 17.857	10 8 17.195	0.662
	24	11 11 59.155	10 11 58.286	0.869
October	2	12 32 55.797	12 32 55.440	0.357
	29	14 13 51.311	14 13 50.810	0.501
December	6	16 51 7.391	16 51 6.822	0.569
	11	17 13 3.878	17 13 3.459	+ 0.419
			Mean by 9 obs. =	+ 0.666

Table XXV.

To show the Differences between the Sun's observed, and computed Right Ascensions; (by Dublin observations.)

1822.

		Sun's R. A. observed at Dublin, reduced by the Greenwich Catalogue.	Sun's R. A. computed for the meridian of Dublin Observatory.	Diff. of the observed and computed R. A.
		h. m. s.	h. m. s.	s.
May	1	2 32 25.302	2 32 24.630	+ 0.672
	21	3 50 31.846	3 50 30.933	0.913
	22	3 54 32.209	3 54 31.344	0.865
	24	4 2 34.538	4 2 33.761	0.777
June	1	4 35 2.653	4 35 2.023	0.630
	3	4 43 14.143	4 43 13.337	0.806
	6	4 55 33.963	4 55 32.956	1.007
	7	4 59 40.987	4 59 40.260	0.727
	22	6 1 56.049	6 1 55.297	0.752
August	2	8 48 5.514	8 48 4.792	0.722
	19	9 52 37.663	9 52 37.128	0.535
	21	10 0 2.983	10 0 2.611	0.372
November	14	15 16 43.041	15 16 42.740	0.301
December	7	16 54 26.289	16 54 25.631	0.658
	26	18 18 32.125	18 18 31.573	+ 0.552
			Mean by 15 obs. =	+ 0.686

Sloane Street,
May 24, 1826.

JAMES SOUTH.

The following was received from Dr. YOUNG whilst the preceding Memoir was in the press.

JAMES SOUTH.

Park Square, 10th July, 1826.

Dear Sir,

I send you some computations of the Sun's longitude from the observations made at Greenwich in 1820, compared with DELAMBRE's Tables, as corrected by BURCKHARDT and BOUVARD, and with CARLINI's, as modified by some slight corrections communicated by Professor SCHUMACHER. The calculations have been made at the expense of the Board of Longitude; and if you think they would tend to illustrate the subject of your Paper, you will perhaps have no objection to inserting them as a note at the end. I have had the same observations reduced by an able astronomer in Germany; but the results are not immediately comparable with these, as they show the errors in right ascension only; and they make the error of CARLINI's tables rather greater than is here represented, amounting to about — 8″ on an average, instead of — 3″ or + 1″; so that the mode of reduction appears to require some further examination.

I am, Dear Sir,
Your faithful and obedient Servant,
THOMAS YOUNG, M. D.

JAMES SOUTH, Esq. &c. &c. &c.

Sec. Bd. Long.

Date.	The Sun's Longitude, by				Error of Delambre's Tables improved.	Error of Carlini's Tables.	Error of Carlini's Tables improved.
	Observation.	Delambre's Tables improved.	Carlini's Tables.	Carlini's Tables improved.			
1820.	° ′ ″	° ′ ″	° ′ ″	° ′ ″	″	″	″
Jan. 1	280 3 48,2	280 3 52,9	280 3 47,2	280 3 51,2	+ 4,7	— 1,0	+ 3,0
3	282 6 7,9	282 6 12,8	282 6 6,8	282 6 11,9	+ 4,9	— 1,1	+ 4,0
5	284 8 27,3	284 8 33,2	284 8 26,8	284 8 32,0	+ 5,9	— 0,5	+ 4,7
15	294 20 8,0	294 20 12,8	294 20 6,9	294 20 11,6	+ 4,8	— 1,1	+ 3,6
16	295 21 20,0	295 21 21,2	295 21 15,7	295 21 20,1	+ 1,2	— 4,3	+ 0,1
22	301 27 51,9	301 27 54,6	301 27 49,0	301 27 52,9	+ ,7	— 2,9	+ 1,0
23	302 28 52,2	302 28 56,6	302 28 51,1	302 28 55,0	+ 4,4	— 1,1	+ 2.8
27	306 32 47,4	306 32 52,2	306 32 46,7	306 32 50,7	+ 4,8	— 0,7	+ 3,3
31	310 36 23,7	310 36 29,8	310 36 23,6	310 36 28,0	+ 6,1	— 0,1	+ 4,3

Date.	The Sun's Longitude, by Observation.	Delambre's Tables improved.	Carlini's Tables.	Carlini's Tables improved.	Error of Delambre's Tables improved.	Error of Carlini's Tables.	Error of Carlini's Tables improved.
1820.	° ′ ″	° ′ ″	° ′ ″	° ′ ″	″	″	″
Feb. 1	311 37 16,0	311 37 21,6	311 37 15,3	311 37 19,8	+ 5,6	— 0,7	+ 3,8
14	324 46 54,9	324 46 57,8	324 46 53,3	324 46 57,0	+ 2,9	— 1,6	+ 2,1
15	325 47 25,0	325 47 33,4	325 47 29,0	325 47 32,6	+ 8,4	+ 4,0	+ 7,6
16	326 48 5,3	326 48 7,5	326 48 3,1	326 48 6,6	+ 2,2	— 2,2	+ 1,3
17	327 48 38,8	327 48 39,8	327 48 35,3	327 48 38,7	+ 1,0	— 3,5	— 0,1
21	331 50 27,0	331 50 29,3	331 50 25,3	331 50 28,5	+ 2,3	— 1,7	+ 1,5
27	337 52 16,0	337 52 14,7	337 52 10,5	337 52 13,9	— 1,3	— 5,5	— 2,1
28	338 52 25,3	338 52 25,7	338 52 21,4	338 52 24,8	+ 0,4	— 3,9	— 0,5
29	339 52 35,3	339 52 34,5	339 52 30,3	339 52 33,7	— 0,8	— 5,0	— 1,6
March 8	347 52 39,5	347 52 43,5	347 52 39,8	347 52 43,5	+ 4,0	+ 0,3	+ 4,0
9	348 52 39,3	348 52 37,1	348 52 33,3	348 52 36,8	— 2,2	— 6,0	— 2,5
10	349 52 28,7	349 52 29,3	349 52 26,0	349 52 29,5	+ 0,6	— 2,7	+ 0,8
11	350 52 23,3	350 52 19,5	350 52 16,4	350 52 19,8	— 3,8	— 6,9	— 3,5
13	352 51 57,8	352 51 54,4	352 51 52,0	352 51 55,2	— 3,4	— 5,8	— 2,6
15	354 51 24,9	354 51 21,9	354 51 19,5	354 51 22,4	— 3,0	— 5,4	— 2,5
23	2 47 48,5	2 47 44,2	2 47 42,5	2 47 44,7	— 4,3	— 6,0	— 3,8
30	9 42 34,9	9 42 34,2	9 42 31,6	9 42 34,3	— 0,7	— 3,3	— 0,6
April 5	15 36 52,2	15 36 49,4	15 36 47,5	15 36 50,5	— 2,8	— 4,7	— 1,7
7	17 34 36,0	17 34 40,4	17 34 38,7	17 34 41,7	+ 4,4	+ 2,7	+ 5,7
11	21 30 3,7	21 30 1,6	21 30 0,4	21 30 3,0	— 2,1	— 3,3	— 0,7
15	25 24 55,7	25 24 53,1	25 24 52,1	25 24 54,3	— 2,6	— 3,6	— 1,4
17	27 22 6,4	27 22 6,6	27 22 6,1	27 22 8,0	+ 0,2	— 0,3	+ 1,6
18	28 20 42,8	28 20 40,0	28 20 39,4	28 20 41,2	— 2,8	— 3,4	— 1,6
19	29 19 14,1	29 19 11,3	29 19 10,8	29 19 12,6	— 2,8	— 3,3	— 1,5
21	31 16 10,5	31 16 7,3	31 16 6,6	31 16 8,4	— 3,2	— 3,9	— 2,1
22	32 14 31,4	32 14 32,1	32 14 31,3	32 14 33,1	+ 0,7	— 0,1	+ 1,7
23	33 12 55,7	33 12 54,8	33 12 53,9	33 12 55,7	— 0,9	— 1,8	0,0
24	34 11 15,4	34 11 15,3	34 11 14,3	34 11 16,2	— 0,1	— 1,1	+ 0,8
25	35 9 38,8	35 9 33,8	35 9 32,7	35 9 34,7	— 5,0	— 6,1	— 4,1
26	36 7 53,7	36 7 50,6	36 7 49,0	36 7 51,1	— 3,1	— 4,7	— 2,6
28	38 4 21,1	38 4 18,4	38 4 16,6	38 4 19,0	— 2,7	— 4,5	— 2,1
29	39 2 34,3	39 2 29,6	39 2 27,6	39 2 30,1	— 4,7	— 6,7	— 4,2
May 5	44 51 3,5	44 51 4,1	44 51 2,6	44 51 5,3	+ 0,6	— 0,9	+ 1,8
7	46 47 9,4	46 47 5,0	46 47 3,4	46 47 6,1	— 4,4	— 6,0	— 3,3
12	51 36 46,7	51 36 44,4	51 36 43,0	51 36 45,2	— 2,3	— 3,7	— 1,5
15	54 30 16,7	54 30 14,9	54 30 13,9	54 30 15,8	— 1,8	— 2,8	— 0,9
21	60 16 33,5	60 16 33,5	60 16 32,6	60 16 34,4	0,0	— 0,9	+ 0,9
22	61 14 9,9	61 14 11,2	61 14 10,0	61 14 11,9	+ 1,3	+ 0,1	+ 2,0
23	62 11 47,8	62 11 47,3	62 11 46,0	62 11 48,0	— 0,5	— 1,8	+ 0,2
24	63 9 23,5	63 9 21,9	63 9 20,7	63 9 22,8	— 1,6	— 2,8	— 0,7
June 1	70 49 18,5	70 49 18,4	70 49 16,0	70 49 18,0	— 0,1	— 2,5	**+ 0,3**
17	86 7 0,9	86 6 59,3	86 6 57,3	86 6 59,6	— 1,6	— 3,6	— 1,3
23	91 50 20,9	91 50 22,2	91 50 19,3	91 50 22,0	+ 1,3	— 1,6	+ 1,1
24	92 47 33,9	92 47 33,9	92 47 30,8	92 47 33,7	0,0	— 3,1	— 0,2
25	93 44 50,1	93 44 45,4	93 44 42,0	93 44 44,9	— 4,7	— 8,1	— 5,2
26	94 41 56,2	94 41 56,5	94 41 53,0	94 41 56,0	+ 0,3	— 3,2	— 0,2
27	95 39 6,6	95 39 7,3	95 39 3,8	95 39 7,0	+ 0,7	— 2,8	+ 0,4
28	96 36 17,0	96 36 18,1	96 36 14,8	96 36 18,2	+ 1,1	— 2,2	+ 1,2
29	97 33 27,4	97 33 29,1	97 33 25,8	97 33 29,3	+ 1,7	— 1,6	+ 1,9

Date.	The Sun's Longitude, by Observation.	Delambre's Tables improved	Carlini's Tables.	Carlini's Tables improved.	Error of Delambre's Tables improved.	Error of Carlini's Tables.	Error of Carlini's Tables improved.
1820.	° ′ ″	° ′ ″	° ′ ″	° ′ ″	″	″	″
July 10	108 2 47,2	108 2 49,8	108 2 45,8	108 2 49,2	+ 2,6	— 1,4	+ 2,0
11	109 0 2,6	109 0 4,3	109 0 0,6	109 0 3,9	+ 1,7	— 2,0	+ 1,3
19	116 38 7,1	116 38 8,6	116 38 4,8	116 38 8,1	+ 1,5	— 2,3	+ 1,0
24	121 24 33,5	121 24 34,8	121 24 30,1	121 24 33,7	+ 1,3	— 3,4	+ 0,2
27	124 16 34,8	124 16 32,4	124 16 28,1	124 16 32,2	— 2,4	— 6,7	— 2,6
30	127 8 40,4	127 8 39,2	127 8 34,7	127 8 38,9	— 1,2	— 5,7	— 1,5
Aug. 1	129 3 28,4	129 3 28,9	129 3 24,4	129 3 29,0	+ 0,5	— 4,0	+ 0,6
7	134 48 29,5	134 48 29,9	134 48 24,9	134 48 29,4	+ 0,4	— 4,6	— 0,1
8	135 46 4,0	135 46 4,3	135 45 59,4	135 46 3,8	+ 0,3	— 4,6	— 0,2
9	136 43 40,1	136 43 39,8	136 43 35,1	136 43 39,4	— 0,3	— 5,0	— 0,7
10	137 41 16,1	137 41 16,8	137 41 11,9	137 41 16,1	+ 0,7	— 4,2	0,0
11	138 38 54,3	138 38 54,6	138 38 49,8	138 38 53,9	+ 0,3	— 4,5	— 0,4
12	139 36 34,7	139 36 33,4	139 36 28,7	139 36 32,8	— 1,3	— 6,0	— 1,9
13	140 34 9,5	140 34 13,1	140 34 8,7	140 34 12,7	+ 3,6	— 0,8	+ 3,2
14	141 31 54,0	141 31 53,7	141 31 49,6	141 31 53,6	— 0,3	— 4,4	— 0,4
18	145 22 46,9	145 22 48,4	145 22 43,6	145 22 47,6	+ 1,5	— 3,3	+ 0,7
19	146 20 35,1	146 20 34,6	146 20 29,7	146 20 33,8	— 0,5	— 5 4	— 1,3
20	147 18 21,5	147 18 21,6	147 18 17,0	147 18 21,3	+ 0,1	— 4 5	— 0,2
27	154 3 35,5	154 3 31,9	154 3 27,3	154 3 32,3	— 3,6	— 8,2	— 3,2
29	155 59 37,0	155 59 32,0	155 59 27,2	155 59 32,5	— 5,0	— 9,8	— 4,5
30	156 57 41,3	156 57 36,4	156 57 31,4	156 57 36,7	— 4,9	— 9,9	— 4,6
Sept. 1	158 53 46,2	158 53 49,4	158 53 44,0	158 53 49,3	+ 3,2	— 2,2	+ 3,1
2	159 52 0,3	159 51 58,9	159 51 53,6	159 51 58,8	— 1,4	— 6,7	— 1,5
3	160 50 14,0	160 50 10,5	160 50 4,9	160 50 10,1	— 3,5	— 9,1	— 3,9
4	161 48 22,7	161 48 23,6	161 48 18,2	161 48 23,4	+ 0,9	— 4,5	+ 0,7
5	162 46 39,0	162 46 38,8	162 46 33,5	162 46 38,6	— 0,2	— 5,5	— 0,4
6	163 44 51,0	163 44 55,7	163 44 50,6	163 44 55,6	+ 4,7	— 0,4	+ 4,6
7	164 43 14,3	164 43 15,1	164 43 9,9	164 43 14,8	+ 0,8	— 4,4	+ 0,5
8	165 41 32,5	165 41 35,7	165 41 30,7	165 41 35,5	+ 3,2	— 1,8	+ 3,0
9	166 39 55,1	166 39 58,2	166 39 53,7	166 39 58,5	+ 3,1	— 1,4	+ 3,4
10	167 38 22,6	167 38 22,5	167 38 18,1	167 38 22,8	— 0,1	— 4,5	+ 0,2
11	168 36 42,0	168 36 48,3	168 36 44,1	168 36 48,7	+ 6,3	+ 2,1	+ 6,7
13	170 33 43,9	170 33 45,3	170 33 41,4	170 33 45,9	+ 1,4	— 2,5	+ 2,0
19	176 25 14,2	176 25 15,8	176 25 11,8	176 25 16,5	+ 1,6	— 2,4	+ 2,3
24	181 18 58,0	181 18 59,9	181 18 55,7	181 19 0,9	+ 1,9	— 2,3	+ 2,9
Oct. 3	190 9 58,1	190 10 2,5	190 9 57,1	190 10 2,6	+ 4,4	— 1,0	+ 4,5
5	192 8 25,4	192 8 28,3	192 8 23,0	192 8 28,3	+ 2,9	— 2,4	+ 2,9
6	193 7 41,2	193 7 44,5	193 7 39,5	193 7 44,7	+ 3,3	— 1,7	+ 3,5
12	199 3 59,1	199 4 3,5	199 3 59,7	199 4 4,4	+ 4,4	+ 0,6	+ 5,3
17	204 1 51,1	204 1 50,5	204 1 46,4	204 1 51,0	— 0,6	— 4,7	— 0,1
28	214 59 42,4	214 59 43,4	214 59 38,4	214 59 43,7	+ 1,0	— 4,0	+ 1,3
Nov. 2	220 0 8,0	220 0 11,4	220 0 6,5	220 0 11,6	+ 3,4	— 1,5	+ 3,6
3	221 0 22,1	221 0 23,4	221 0 18,7	221 0 23,7	+ 1,3	— 3,4	+ 1,6
16	234 5 28,7	234 5 32,2	234 5 28,3	234 5 32,4	+ 3,5	— 0,4	+ 3,7
18	236 6 35,6	236 6 40,4	236 6 36,8	236 6 41,1	+ 4,8	+ 1,2	+ 5,5
19	237 7 10,3	237 7 16,7	237 7 13,1	237 7 17,5	+ 6,4	+ 2,8	+ 7,2
27	245 12 51,7	245 13 1,0	245 12 56,4	245 13 1,2	+ 9,3	+ 4,7	+ 9,5
Dec. 14	262 29 41,5	262 29 47,0	262 29 43,3	262 29 46,6	+ 5,5	+ 1,8	+ 5,1
28	276 45 34,6	276 45 40,6	276 45 35,7	276 45 39,5	+ 6,0	+ 1,1	+ 4,9
					+ 177,0	+ 21,4	+ 164,5
					— 94,6	— 335,6	— 83,6
					± 271,6	± 357,0	± 248,1
					+ 82,4	— 314,2	+ 80,9

XXIX. *On the existence of a limit to vaporization.* *By* M. FARADAY, *F. R. S. Corresponding Member of the Royal Academy of Sciences at Paris, &c. &c. Communicated May 26, 1826.*

Read June 15, 1826.

IT is well known that within the limits recognised by experiment, the constitution of vapour* in contact with the body from which it rises, is such, that its tension increases with increased temperature, and diminishes with diminished temperature; and, though in the latter case we can, with many substances, so far attenuate the vapour as soon to make its presence inappreciable to our tests, yet an opinion is very prevalent, and I believe general,† that still small portions are produced; the tension being correspondent to the comparatively low temperature of the substance. Upon this view, it has been supposed that every substance in vacuo or surrounded by vapour or gas, having no chemical action upon it, has an atmosphere of its own around it; and that our atmosphere must contain, diffused through it, minute portions of the vapours of all those substances with which it is in contact, even down to the earths and metals. I believe that a theory of meteorites has been formed upon this opinion.

Perhaps the point has never been distinctly considered;

* By the term vapour, I mean throughout this paper that state of a body in which it is permanently and indefinitely elastic.

† See Sir H. DAVY's paper on Electrical Phenomena exhibited in Vacuo. Phil. Trans. MDCCCXXII. p. 70.

and it may therefore not be uninteresting to urge two or three reasons, in part dependant upon experimental proof, why this should not be the case. The object, therefore, which I shall hold in view in the following pages, is to show that a *limit* exists to the production of vapour of any tension by bodies placed in vacuo, or in elastic media, beneath which limit they are perfectly fixed.

Dr. Wollaston, by a beautiful train of argument and observation, has gone far to prove that our atmosphere is of finite extent, its boundary being dependant upon the opposing powers of elasticity and gravitation.* On passing upwards, from the earth's surface, the air becomes more and more attenuated, in consequence of the gradually diminishing pressure of the superincumbent part, and its tension or elasticity is proportionally diminished; when the diminution is such, that the elasticity is a force, not more powerful than the attraction of gravity, then a limit to the atmosphere must occur. The particles of the atmosphere there tend to separate with a certain force; but this force is not greater than the attraction of gravity, which tends to make them approach the earth and each other; and as expansion would necessarily give rise to diminished tension, the force of gravity would then be strongest, and consequently would cause contraction, until the powers were balanced as before.

Assuming this state of things as proved, the air at the limit of the atmosphere has a certain degree of elasticity or tension; and, although it cannot there exist of smaller tension, yet, if portions of it were removed to a farther distance from the earth, or if the force of gravity over it could in any other way

* Phil. Trans. MDCCCXXII. p. 89.

be diminished, then it would expand, and exist of a lower tension; upon the renewal of the gravitating force, either by approximation to the earth's surface or otherwise, the particles would approach each other, until the elasticity of the whole was again equal to the force of gravity.

Inasmuch as gases and vapours undergo no change by mere expansion or attenuation, which can at all disturb the analogy existing between them in their permanent state under ordinary circumstances, all the phenomena which have been assumed as occurring with the air at the limit of our atmosphere may, with equal propriety, be admitted with respect to vapour in general in similar circumstances; for we have no reason for supposing that the particles of one vapour more than another are *free* from the influence of gravity, although the force may, and without doubt does, vary, with the weight and elasticity of the particles of each particular substance.

It will be evident, also, that similar effects would be produced by the force of gravity upon air or vapour of the extreme tenuity and feeble tension referred to, whatever be the means taken to bring it into that state; and it is not necessary to imagine the portion of air operated upon, as taken from the extremity of our atmosphere, for a portion of that at the earth's surface, if it could be expanded to the same degree by an air pump, would undergo the same changes: when of a certain rarity it would just balance the attraction of gravitation and fill the receiver with vapour; but then, if half were taken out of the receiver, the remaining portion, in place of filling the vessel, would submit to the force of gravity, would contract into the lower half of the receiver,

until, by the approximation of their particles, the vapour there existing should have an elasticity equal to the force of gravity to which it was subject. This is a necessary consequence of Dr. WOLLASTON's argument.

There is yet another method of diminishing the elasticity of vapour, namely, by diminution of temperature. With respect to the most elastic substances, as air, and many gases, the comparatively small range which we can command beneath common temperatures, does nothing more at the earth's surface than diminish in a slight degree their elasticity, though two or three of them, as sulphurous acid and chlorine, have been in part condensed into liquids. But with respect to innumerable bodies, their tendency to form vapour is so small, that at common temperatures the vapour produced approximates in rarity to the air upon the limits of our atmosphere; and with these, the power we possess of lessening tension by diminution of temperature, may be quite sufficient to render it a smaller force than its opponent, gravity; in which case it will be easy to comprehend that the vapour would give way to the latter, and be entirely condensed. The metal, silver, for instance, when violently heated, as on charcoal urged by a jet of oxygen, or by the oxy-hydrogen, or oxy-alcohol flame, is converted into vapour; lower the temperature, and before the metal falls beneath a white heat, the tension of the vapour is so far diminished, that its existence becomes inappreciable by the most delicate tests. Suppose, however, that portions are formed, and that vapour of a certain tension is produced at that temperature; it must be astonishingly diminished by the time the metal has sunk to a mere red heat; and we can hardly conceive it possible, I think,

that the silver should have descended to common temperatures, before its accompanying vapour will, by its gradual diminution in tension, if uninfluenced by other circumstances, have had an elastic force far inferior to the force of gravity; in which case, that moment at which the two forces had become equal, would be the last moment in which vapour could exist around it; the metal at every lower temperature being perfectly fixed.

I have illustrated this case by silver, because, from the high temperature required to make any vapour appreciable, there can be little doubt, that the equality of the gravitating and elastic forces, must take place much above common temperatures, and therefore within the range which we can command. But there is, I think, reason to believe that the equality in these forces, at or above ordinary temperatures, may take place with bodies far more volatile than silver; with substances indeed which boil under common circumstances at 600° or 700° F.

If, as I have formerly shown,* some clean mercury be put at the bottom of a clean dry bottle, a piece of gold leaf attached to the under part of the stopper by which it is closed, and the whole left for some months at a temperature of from 60° to 80°, the gold leaf will be found whitened by amalgamation, in consequence of the vapour which rises from the mercury beneath; but upon making the experiment in the winter of 1824-5, I was unable to obtain the effect, however near the gold leaf was brought to the surface of the mercury; and I am now inclined to believe, because the elastic force of any vapour which the mercury could have produced at that

* Quarterly Journal of Science, X. 354.

temperature, was less than the force of gravity upon it, and that consequently the mercury was then perfectly fixed.

Sir HUMPHRY DAVY, in his experiments on the electrical phenomena exhibited in vacuo, found, that when the temperature of the vacuum above mercury was lowered to 20° F. no further diminution, even down to —20° F. was able to effect any change, as to the power of transmitting electricity, or in the luminous appearances; and that these phenomena were then nearly of the same intensity as in the vacuum made over tin.* Hence, in conjunction with the preceding reasoning, I am led to conclude, that they were then produced independant of any vapour of the metals, and that under the circumstances described; no vapour of mercury existed at temperatures beneath 20° F.

Concentrated sulphuric acid boils at about 600° F. but as the temperature is lowered the tension of its vapour is rapidly diminished. Signor BELLANI† placed a thin plate of zinc at the upper part of a closed bottle, at the bottom of which was some concentrated sulphuric acid. No action had taken place at the end of two years, the zinc then remaining as bright as at first; and this fact is very properly adduced in illustration of the fixedness of sulphuric acid at common temperatures. Here I should again presume, that the elastic force which tended to form vapour, was surpassed by the force of gravity.

Whether it be admitted or not, that in these experiments the limit of volatilization, according to the principle of the balance of forces before stated had been obtained, I think, we can hardly doubt that such is the case at common temperatures, with respect to the silver, and with all bodies which

* Phil. Trans. MDCCCXXII. p. 71. † Gionale di Fisica, v. 197.

bear a high temperature without appreciable loss by volatilization, as platina, gold, iron, nickel, silica, alumina, charcoal, &c.; and, consequently that, at common temperatures, no portion of vapour rises from these bodies or surrounds them; that they are really and truly fixed; and that none of them can exist in the atmosphere in the state of vapour.

But there is another force, independent of that of gravity, at least of the general gravity of the earth, which appears to me sufficient to overcome a certain degree of vaporous elasticity, and, consequently, competent to the condensation of vapour of inferior tension, even though gravity should be suspended; I mean the force of homogeneous attraction.

Into a clean glass tube, about half an inch in diameter, introduce a piece of camphor; contract the tube at the lamp about four inches from the extremity; then exhaust it, and seal it hermetically at the contracted part; collect the camphor to one end of the tube; and then, having placed the tube in a convenient position, cool the other end slightly, as by covering it with a piece of bibulous paper preserved in a moist state by a basin of water and thread of cotton; in this way, a difference in temperature of a few degrees will be occasioned between the ends of the tube, and after some days, or a week or two, crystals of camphor will be deposited in the cooled part; there will not, however, be more than three or four of them, and these will continue to increase in size as long as the experiment is undisturbed, without the formation of any new crystals, unless the difference of temperature be considerable.

A little consideration will, I think, satisfy us that, after the first formation of the crystals in the cooled part, they have

the power of diminishing the tension of the vapour of camphor, below that point at which it could have remained unchanged in contact with the glass, or in space: for the vapour of the camphor is of a certain tension in the cooled end of the tube, which it can retain in contact with the glass, and therefore it remains unchanged; but which it cannot retain in contact with the crystal of camphor, for there it is condensed, and continually adds to its mass. Now, this can only be in consequence of a positive power in the crystal of camphor of attracting other particles to it; and the phenomena of the experiment are such as to show, that the force is able to overcome a certain degree of elasticity in the surrounding vapour. There is therefore no difficulty in conceiving, that, by diminishing the temperature of a body and its atmosphere of vapour, the tension of the latter may be so far decreased, as at last to be inferior to the force with which the solid portion, by the attraction of aggregation, draws the particles to it; in which case it would immediately cause the entire condensation of the vapour.

The preceding experiment may be made with iodine, and many other substances; and indeed there is no case of distinct crystallization by sublimation * which does not equally afford evidence of the power of the solid matter, to overcome a positive degree of tension in the vapour from which the crystals are formed. The same power, or the force of aggregation, is also illustrated in crystallizing solutions; where the solution has a tendency to deposit upon a crystal, when it has not the same tendency to deposit elsewhere.

It may be imagined that crystallization would scarcely go

* Calomel, corrosive sublimate, oxide of antimony, naphthaline, oxalic acid, &c. &c.

on from these attenuated vapours, as it does in the denser states of the vapours experimented upon. There is, however, no good reason for supposing any difference in the force of aggregation of a solid body, dependent upon changes in the tension of the vapour about it; and indeed, generally speaking, the method I have assumed for diminishing the tension of the vapour, namely, by diminishing temperature, would cause increase in the force of aggregation.

Such are the principal reasons which have induced me to believe in the existence of a limit to the tension of vapour. If I am correct, then there are at least two causes, each of which is sufficient to overcome and destroy vapour when reduced to a certain tension; and both of which are acting effectually with numerous substances upon the surface of the earth, and retaining them in a state of perfect fixity. I have given reasons for supposing that the two bodies named, which boil at about 600° F. are perfectly fixed within limits of low temperature which we can command; and I have no doubt, that, nearly all the present recognised metals, the earths, carbon, and many of the metallic oxides, besides the greater number of their compounds, are perfectly fixed bodies at common temperatures. The smell emitted by various metals when rubbed may be objected to these conclusions, but the circumstances under which these odours are produced, are such, as not to leave any serious objections on my mind to the opinions above advanced.

I refrain from extending these views, as might easily be done, to the atomic theory, being rather desirous that they should first obtain the sanction or correction of scientific men. I should have been glad to have quoted more experiments

upon the subject, and especially relative to such bodies as acquire their fixed point at, or somewhat below common temperatures. Captain FRANKLIN has kindly undertaken to make certain experiments for me in the cold regions to which he has gone, and probably when he returns from his arduous undertaking, he may have some contributions towards this subject.

Royal Institution,
May 4, 1826.

XXX. *On electrical and magnetic rotations.* By CHARLES BABBAGE, *Esq. F.R.S. &c. &c. Communicated May* 29, 1826.

Read June 15, 1826.

THE known fact, that artificial magnets receive additional increments to their power by slowly adding weight to the load they support, combined with the circumstance, that pieces of iron or steel exposed to the influence of a magnet, neither acquire nor lose their magnetism instantaneously, led me to explain Mr. BARLOW's experiments "On the temporary magnetic effect induced in iron bodies by rotation,"* without having recourse to any new property of matter, and to apply the same consideration of the time of acquiring and losing magnetic virtue to the curious experiments of M. ARAGO. These views are stated in a paper printed in the Phil. Trans. for 1825, which contains the observations that occurred to Mr. HERSCHEL and myself, in repeating and varying those experiments.

As the explanation there given is intimately connected with the experiments detailed in the present paper, and as they were undertaken with a view of giving additional evidence to the principle to which I have alluded, I shall here briefly re-state the manner in which time influences the results of certain magnetic phenomena, whose production depends on the application of motion to some part of the apparatus employed.

* Phil. Trans. 1825.

Fig. 1.

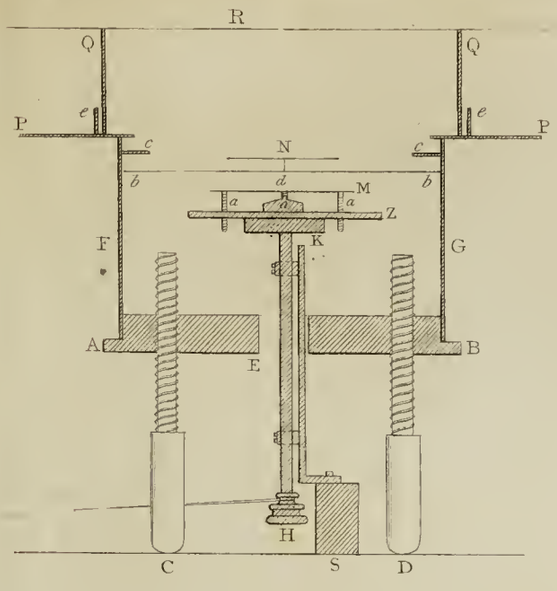


Fig. 2.

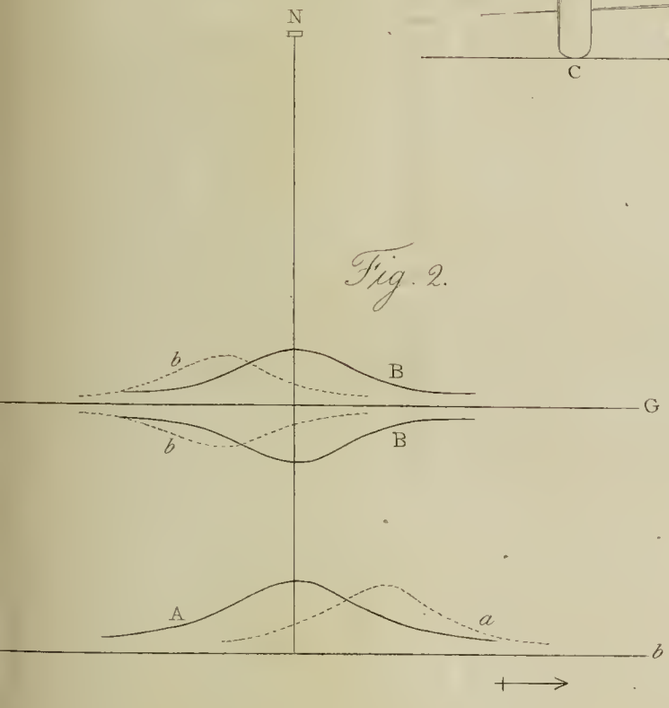
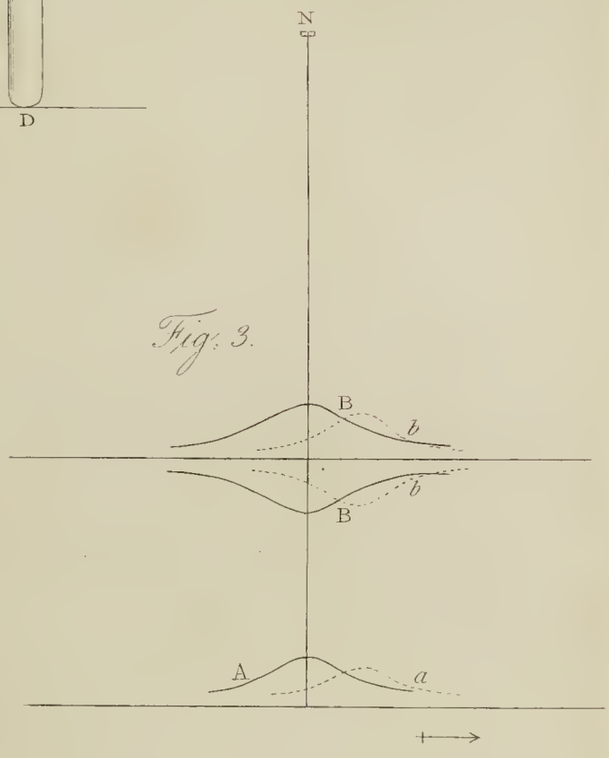


Fig. 3.



N

Fig. 4.

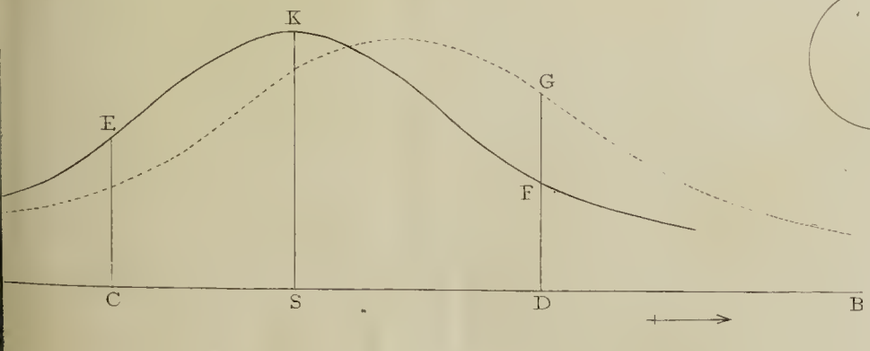
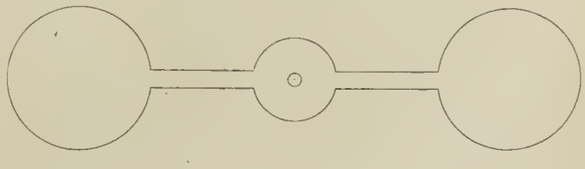


Fig. 5.



If N represent the north pole of a magnet, Plate XIX, fig. 4, placed above an indefinite plate AB, of iron or any substance susceptible of magnetism, then the point S immediately under N will become a south pole from induced magnetism: but the two poles will attract each other, and if they are prevented from moving directly towards each other, motion cannot arise in any other direction. The point S immediately under N will possess the strongest south polarity, but other adjacent points will also acquire the same property in a smaller degree: if an ordinate SK be erected at S, and if at every other point in the line AB other ordinates be raised, each proportional to the intensity of the induced magnetism at that point, a curve EKF will be formed, which will represent the magnetic force of the plate, and at equal distances CS, SD, on each side of the point S the ordinates EC and FD will be equal.

If the plate is now supposed to be moved in the direction AB, and if the time in which it acquires or gives up any portion of magnetism be not instantaneous, then the ordinates which represent the magnetic intensities at equal distances from the middle point S will not be equal: for the point D has, in consequence of the motion of the plate, just passed through a point S, considerably nearer to the source of magnetism, at which point its magnetic intensity was expressed by SK. As it is supposed not to part immediately with its acquired magnetism, some portion will remain when it reaches the point D: therefore the ordinate DG, at this point, will be greater than it is when the plate is at rest; consequently the curve EKG, expressing the magnetic force when the plate is in motion, will, on the side towards

which the motion is directed, be exterior to that which denotes the same force when the plate is at rest. But in the case of the plate being in motion, the force which is measured by the area of the curve is greater on one side than on the other; there will therefore be a small tendency in the plate to draw the point N towards that side to which it is moving. The points which have not passed vertically under the pole N, will in reality be a little less magnetised than they would be if they were at rest, because when they reach any particular place, they may not be exposed to the magnetic influence for a time sufficient for them to acquire the full degree of magnetism which they would obtain, if they remained longer in that place. If the moving plate be circular, and if the magnet be suspended in a balance of torsion, this extremely small tendency of each part to drag the pole N in the direction of its motion being repeatedly applied by each succeeding particle, and during many revolutions, may at last produce motion in the magnets above, even though the attractive force of the revolving substance be so exceedingly feeble as to be insensible to other methods.

In this analysis of the action of a magnet on a moving body susceptible of magnetism, it is to be observed, that no part of the effect is attributed to the velocity with which the agent* immediately producing the attraction traverses from the former to the latter: the nature of the action is not

* It is difficult to write on any physical subject without employing words which are more or less connected with the various hypotheses prevailing at the time. In the present Paper I have no intention of giving any opinion on the theories at present received, but merely propose stating facts that I have noticed, and the reasonings to which they appear to me to lead.

therefore analogous to that which produces the aberration of light.

The essential circumstance in producing the rotation of the suspended magnet is, that the substance revolving below it shall acquire and lose its magnetism in a finite time, and not instantly. It appeared, therefore, that if any other attractive or repulsive property exists in matter which is capable of communication to other matter situated near it; and if such communication require time for its performance; and if, when it is communicated, the force is not instantly annihilated on removing the cause, then such a property of matter may be substituted in the preceding reasoning instead of magnetism, the same deductions may be made, and similar consequences may be expected to result. On reviewing the known properties of matter, electricity seemed to be the only one which satisfied the requisite conditions: imperfect conductors placed in the neighbourhood of excited bodies do not immediately attain a state of electric equilibrium; and when they have arrived at that state which is due to such a position, on the removal of the excited body they do not instantly return to their former state. I therefore made the following experiments.

Experiment 1.

A needle was made of thin sheet brass, of the form, fig. 5, having two circular ends 1.25 inches in diameter, and the distance of their centres 3.1 inch; it had its edges coated with sealing-wax. Another similar needle was made, about one-third larger. One of these needles was suspended from a filament of silk, of several feet in length, at the distance of .25 inch above a circular glass plate six inches

in diameter, which was fixed by sealing-wax on a disc of box wood 2.5 inches in diameter: this latter was screwed upon a wooden axis. No electricity was communicated either to the needle or the glass disc, except that which resulted from cementing the latter by sealing-wax to the box wood on which it was fastened, and perhaps the coating of wax on the edges of the needle might have given it a very slight charge. The glass disc was now made to revolve at about 38 revolutions in a minute: there was a small motion of the needle in the same direction.

Experiment 2.

The same apparatus being employed, a large stick of common sealing-wax was excited and applied two or three times to the needle, in order to charge it. As soon as it was quite at rest, the glass disc was made to revolve more slowly than before, when the needle began to deviate in the direction of rotation, and followed the glass. Some doubt being expressed by a friend who was present as to the influence of the air set in motion by the apparatus, the electric charge of the needle was increased, and the velocity of rotation was diminished: the needle deviated as before, but much more rapidly. To remove some doubt as to the influence of any twist in the silk; whilst the needle was revolving in one direction, the rotation of the glass disc was reversed; after a short time the motion of the needle was destroyed, and it returned in the contrary direction.

For the purpose of ascertaining still more satisfactorily the effect which might be ascribed to the influence of air, the following experiment was made.

Experiment 3.

The apparatus was left many hours, in order that the electricity of its parts might, as far as possible, be dissipated. On returning to it, the glass disc was made to revolve with very great rapidity: not the slightest sensible effect was produced on the needle.

Experiment 4.

The needle was now electrified, and the same velocity being given to the glass plate, and all the other circumstances being the same,—the needle followed slowly. On trying various degrees of velocity, it was observed, that the effect on the needle was greatest when the motion of the glass plate was slow. A velocity of about five turns in a minute produced a considerable effect.

Experiment 5.

A stick of excited sealing-wax was substituted for the brass needle, and placed at the distance of about half an inch above the glass disc. On giving a slow motion to the glass plate, the wax needle followed in the same direction, and continued to move through many revolutions, notwithstanding the torsion of the silk; but on giving the glass a very rapid rotation, the sealing-wax needle remained nearly immoveable.

Experiment 6.

A new apparatus was constructed, which is represented in fig. 1. It consisted of a circular piece of wood A B, 9 inches diameter, having a hole of 1.5 inches in the centre,

supported by three legs, two of which only, C and D, are represented in the figure; these, by screwng into it, served to adjust its height. A cylinder of thick millboard F G, 5 inches high, was glued together, and was fastened to the board A B. In two very small recesses in its upper part rested a narrow bridge of glass or of wood *b b*, for the purpose of supporting a needle. A circular ring of pasteboard *c c*, was fixed near the top, which supported an engraved circle divided into degrees. A square piece of millboard P P, having a circular opening rather less than the diameter of the cylinder, rested on the top of it. Upon this was placed another millboard cylinder Q Q, of rather larger diameter, and $2\frac{3}{4}$ inches high. Another cylinder was fitted to the outside of this, in order to admit of fixing screens of muslin and various substances to the under side of the upper cylinder.

Through the aperture in the centre of the wooden plate A B, a steel axis working in a brass frame passed up into the cylinder. The frame was supported by being screwed to a block of wood at S. On the lower end of this axis a pulley H, was fixed, to which motion was given by connecting it with a common jack. On the upper end of this axis a thin brass chuck K 2 inches in diameter, was fixed, to which was attached a wooden disc Z, 5 inches in diameter. Three wooden screws *a a a*, rose from this plate, and supported a disc M, of any substance on which experiments were to be made.

A needle made of pasteboard covered with sealing-wax, and having an agate cap in its centre, was supported on the point of a steel sewing needle fixed in a wooden bridge .05 inch square. A plate of glass revolved below. The

following were the times in which different revolutions were performed.

When the glass disc made $26\frac{1}{2}$ turns per minute.			When the glass disc made $19\frac{7}{8}$ turns per minute.		
Number of Revolutions.	Time.	Difference.	Number of Revolutions.	Time.	Difference.
	′ ″	″		′ ″	″
0	21 0	49	0	34 0	52
·25	21 49	26	·25	34 52	28
·5	22 15	15	·50	35 20	17
·75	22 30	15	·75	35 37	15
1	22 45	42	1	35 52	45
2	23 27	35	2	36 50	43
3	24 2	35	3	37 35	40
4	24 37	33	4	38 18	39
5	25 10	32	5	38 58	38
6	25 42	32	6	39 37	40
7	26 12	29	7	40 15	40
8	26 44	38	8	40 55	43
9	27 16	30	9	41 35	41
10	27 45		10	42 18	

In the latter of these experiments, at the seventh revolution, the passing of a carriage may have slightly affected the remaining revolutions.

Experiment 7.

A thin disc of copper, such as is used for engraving upon, about seven inches in diameter, was connected by wax with the glass plate employed in experiment 1, and the same apparatus was used with a needle of sealing-wax suspended above: on making the copper plate revolve rather quickly, the needle followed it, and went through two revolutions. Several plates of lead, pewter, brass and copper were tried, and the results were similar.

For the purpose of procuring more powerful and durable charges of electricity, I placed a small excited electrophorus on the three screws *a, a, a*, fig. 1, the copper plate was placed upon it. A very thin slip of glass *b, b*, formed a bridge, on the centre of which various needles were supported. The effects which resulted were not constantly the same, aad the unequal distribution of electricity on the electrophorus, combined with the action of the glass bridge, seemed to present very complicated results. I shall only detail one of these experiments.

Experiment 8.

The apparatus just referred to being employed, and the electrophorus without a copper plate being used, a needle of thin brass, similar in shape to that of experiment 1, with an agate cap, was supported by a fine needle point fixed by cement to the centre of the glass bridge. The brass needle rested nearly at right angles to the glass bridge (strictly at 98° from it).

On giving a slow motion to the electrophorus, the brass needle immediately advanced in the same direction about 10°, then stopped, then returned back to its original position, and, after a few vibrations, settled at a point 2° in advance of its original position. On increasing the speed of the electrophorus, the needle again advanced, and settled at between 3°½ and 4° in advance of its first position. The velocity was again considerably increased, when the brass needle began to oscillate in a vertical direction, and the stationary point advanced to 9° or 10°, where it remained steadily, except that the vertical motion continued

The velocity was again increased, when the stationary

point moved on to 12° from its position at the beginning of the experiment. On stopping the motion, the needle advanced 115°, and then rested.

These experiments appear to me to admit of explanation, on precisely the same principles which I had previously applied to those relating to magnetism. It seems that electricity excited by induction is not *instantly* destroyed by removing the inducing body; nor is it instantly excited, to the full extent which the circumstances admit, on presentig an excited to an unexcited body. Admitting this principle, the whole of the reasoning which was given at the commencement of this paper, relative to rotations from magnetic causes, applies equally to those which arise from electricity.

The velocity with which electricity travels, has been urged as an objection to this explanation of the phenomena; and the immense rapidity with which the metals conduct that fluid, renders it difficult to admit that the motions employed in these experiments are at all comparable with that of electricity. There are two circumstances that may be stated as some explanation of this difficulty: the first is, that although the forces thus set in action are exceedingly weak, yet, from the nature of the apparatus, they act constantly for a considerable time, and in the same direction; thus gaining, by the duration of their total action, a power far superior to the almost infinitely small one which arises from the transient action of each part: the second is, that although the velocity with which electricity of considerable intensity moves through good conductors is excessively great, I am not aware of any experiments which prove that the small inequalities which are produced in a very weakly electrified body by induction from

some neighbouring body, are removed with the same velocity. The analogy of a fluid similarly circumstanced, would lead us to infer, that when the deviations above the level are minute, the return to it will be more slow.

Of Screens.

Although the preceding experiments, when repeated under various circumstances, had convinced me that the rotations which had been observed were not attributable to currents of air set in motion by the apparatus employed, I was desirous of examining what effect would result from the interposition of a screen. I therefore suspended the needles I employed by a silver wire, $\frac{1}{500}$ inch in diameter, and about two feet in length, which was contained in a glass tube, supported over the middle of the apparatus represented in fig. 1. This tube and wire passed through a circular hole in the centre of the glass plate R. The bridge *b b*, was removed, and a screen of fine muslin was stretched across the bottom of the lower cylinder Q, by means of the external one *c c*. This screen and the needles were occasionally changed.

Experiment 9.

A brass needle, having a very fine thread of spun glass cemented to one end by a little wax, was suspended by the silver, about $\frac{1}{8}$ inch above a screen of coarse gauze (not silk). A pewter disc, of 4 inches in diameter, was placed on the revolving stand, $\frac{3}{16}$ inch below the gauze screen. Neither the needle nor the disc were electrified; and they were completely protected from any currents of air moving about in the room in which these experiments were made.

The three first oscillations of the needle were:

1st. 127.8
2nd. 126
3rd. 127.8

The disc was then set in motion, and kept revolving at about 78 turns in a minute. After six minutes no result was apparent in the needle different from those which had been observed before the motion commenced. This seems to show that the action of air, if it is driven through the screen, is insensible.

Experiment 10.

Having placed a screen of coarse gauze above the pewter plate at $\frac{1}{8}$ inch distant, an excited needle of sealing-wax was substituted for that of brass. I observed the extent of the oscillations, and then setting the plate of pewter in motion, I was surprised to find that the returning arc (contrary to the direction of the plate's motion) was almost invariably increased, generally at the first, and almost constantly at the second oscillation, and that the arc in the same direction was diminished.

So unexpected a result naturally induced me at first to attribute it to some error in the observations; but on repeating it many times, and having measured the greatest error which the means I employed were susceptible of when used even a little carelessly, I found that half a degree was the greatest error I could make in reading off the oscillations, and that this retrograde motion was in many cases equal to three,

four, or five degrees; so that the measure of the observed fact was from four to eight times the extent of the greatest possible error of observation, even admitting it to take place at both extremities. It is true, I did not always observe this retrograde motion; but in twenty experiments the needle, screen and plate, not being always at the same relative distances, I noticed it seventeen times. The next step seemed to be to find some mode of encreasing the unequal distribution of electricity on the metallic plate, supposing that to be the cause of the phenomena. I therefore made a very small lamp, which being lighted, was placed on the stage L of the revolving apparatus, immediately under the copper. It was afterwards found convenient to make a small aperture in the lower millboard cylinder, just opposite the platform supporting the lamp, for the purpose of lighting it when requisite: this opening was closed by a piece of mica, fastened on a card.

Experiment 11.

A small stick of sealing-wax being suspended from the silver wire above a leno muslin screen, the pewter plate was supported just above the lamp, and under the screen, the following observations were made:

Oscillations of the needle.	Diff.	½ Diff.	Mean point.
0	0	0	0
R .... 16 L 18	2	1	17
The lamp was now lighted.			
R .... 15.5 L 25	19.5	4.75	20.25
R .... 18 L 31	13	6.5	24.5
R .... 14 L 34	20	10	24
R .... 14.25 L 33.2	19	9.5	23.7
R .... 16 L 28	12	6	22
R .... 21 L 25	4	2	23
R .... 20 L 29	9	4.5	24.5

The wax now became more heated, and gradually bent until the glass index touched the graduations. The number of revolutions of the pewter plate and lamp were 56 per minute.

Experiment 12.

The same apparatus being used, a brass needle was substituted for that of sealing-wax; it was suspended ½ inch above the leno muslin screen, which was ⅛ inch above the pewter plate; these distances were the same in Experiment 11. The plate and lamp made 56 revolutions per minute.

The observations were made as in the last experiment. The apparatus being at rest, the mean point was 2°.

Oscillations.	Diff.	½ Diff.	Mean point.
R.....0	0	0	0
L.....4	4	2	2
Lighted lamp, and set it and plate revolving.			
R — .5	11	5.5	5
L + 10.5			
R — 1.5	13.5	6.75	5.25
L + 12			
R — 8	18.5	9.25	1.25
L + 10.5			
R — 5.8	9.8	4.9	—0.9
L + 4			
R — 3	9.5	4.75	+ 1.75
L + 6.5			
R — 9.5	19.0	9.5	0.
L + 9.5			
R — 13.5	25.5	12.75	—0.75
L + 12			
R — 15	32	16.0	+ 1.0
L + 17			
R — 14	26	13.0	— 1.0
L + 12			
R — 11	20	10	— 1.0
L + 9			

The lamp burned with a very dull flame, $\frac{3}{16}$ inch long, the top of the flame about $\frac{5}{8}$ inch below the pewter disc; it was lighted by a small stick, which burnt with a flame, and gave more heat than the lamp during the short time it was under the plate. This experiment lasted about twenty minutes.

Experiment 12.

The same brass needle being used in the same apparatus; the distances remaining as before, the lamp was trimmed, so as to give a much brighter flame.

Oscillations of needle.	Diff.	½ Diff.	Mean point.
°	°	°	°
L..... 0			
R..... 2	2	1	+ 1
The lamp was now lighted, and set in motion.			
L — 5			
R + 2.5	7.5	3.75	— 1.25
L — 1			
R + 6.5	7.5	3.75	+ 2.75
L — 3.5			
R + 6.5	10.0	5.0	+ 1.5
L — 5.0			
R + 7.0	12.0	6.0	+ 1
L — 4.5			
R + 6.0	10.5	5.25	+ 0.75
L — 3.5			
R + 9.5	13.0	6.5	+ 3.0
L — 5.4			
R + 4.5	9.9	4.95	— .45
L — 4.5			
R + 4.0	8.5	4.25	— .25
L — 2.0			
R + 5.5	7.5	3.75	+ 1.75
L — 3.0			
R + 7.0	10.0	5.0	+ 2.0
L — 4.0			
R + 6.0	10.0	5.0	+ 1
L — 4.0			
R + 6.0	10.0	5.0	+ 1
L — 3.5			
R + 9.0	12.5	6.25	+ 2.75
L — 10			
R + 11.5	21.5	10.75	+ .75
L — 6.5			
R + 10.0	16.5	8.25	+ 1.75
L — 6.0			
R + 5.0	11.0	5.5	— 0.5
L — 8.0			
R + 15.0	23.0	11.5	+ 3.5
L — 14.5			
R + 16.0	30.5	15.25	+ 0.75.
L — 15.0			
R + 17.5	32.5	16.25	+ 1.25
L — 19.5			
R + 17.0	36.5	18.25	— 1.25

Soon after the commencement of the experiment a mist arose within the case, which continued about five or six minutes: this frequently happened in the other experiments. The duration of the observations was about twenty-five minutes in the two preceding experiments.

On examining the column of the mean point of the needle, I am not inclined to draw any inference respecting it: whatever action may have been exerted on it, does not appear to have produced a marked or decisive effect on that point. I was induced to insert them, from the circumstance of the remarkable and gradual increase of the arc of vibration in both instances. This will be observed on looking down the columns of half differences, which is, in fact, the amplitude of each oscillation about the mean point.

The observed retrograde movement in the eleventh experiment being so small, and yet exceeding many times the greatest possible error of observation, I was now desirous of enquiring whether, amongst the accidental circumstances to which the needle was exposed, there might not be found some one to whose influence this apparent anomaly might be ascribed. The number of causes to which it might be attributed was considerable; but I hoped by variations in the circumstances of the experiment gradually to eliminate them.

The following list comprised the greater part of them. The reverse motion might arise from, 1. Currents of air in the room; 2. From currents of air excited within the apparatus; 3. By air driven through the gauze screen; 4. By heated air rising from the metal plate heated by the lamp; 5. By the vibration excited in the apparatus by the motion of the jack; 6. By the torsion of the silver wire to which the

needles were attached; 7. By the electricity of the bridge; 8. By the bending of the wax needle.

The first of these causes, namely, the action of currents of air in the room in which these experiments were made, was obviated by the form of the apparatus in which the needle was afterwards inclosed, and care was taken to render all the parts of it as close as possible.

The second source of this retrograde motion might be supposed to arise from the movement impressed on the air within the lower cylinder of millboard being communicated through the screen, not by actually passing through its apertures, but by the vibrations it might impress on it. The fact of the direction of the motion in the lower cylinder being in the contrary direction to that of the needle in the upper one, was exceedingly unfavourable to this hypothesis.

Before I relate the various experiments which I made, with the view of successively placing each of these causes out of action, I think it may be necessary to detail a few additional experiments, in confirmation of the fact.

Experiment 13.

Using the same apparatus, I substituted a disc of copper, 5 inches in diameter, and $\frac{1}{16}$ inch thick, instead of that of pewter; the sealing-wax needle was suspended half an inch above the leno screen; the lamp was placed at one inch from the edge of the copper plate, towards its centre:—the flame was large and smoky.

Oscillations of needle.	Diff.	½ Diff.	Mean point.
°	°	°	
L ... 347.8			
R ... 343.6	4.2	2.1	345.7
L ... 347.0			
R ... 343.5	3.5	1.75	345.25
The lamp was now lighted.			
L ... 348			
R ... 344	4	2	346
L ... 339.5			
R ... 346	6.5	3.25	342.75
L ... 331.2			
R ... 337	5.8	2.9	334.1
L ... 330			
R ... 339	9	4.5	334.5
L ... 334			
R ... 337	3	1.5	335.5
L ... 330			
R ... 342.5	12.5	6.25	336.25
L ... 332.5			
R ... 356.5	24.0	12.0	344.5
L ... 341.4			
R ... 396	54.6	27.3	368.7

At one part of this experiment the needle became stationary, as if it had arrived at the end of its arc; it then went on again in the same direction as before. This stationary point should perhaps be considered as the extreme right of one vibration, and the extreme left of the next: I have noticed it more than once in these inquiries. The column of the mean point of the needle has, in this experiment, marked the same retrograde motion on the first application of heat, and the same motion in advance, when that heat has continued, as in former ones.

Experiment 14.

The same apparatus; the copper disc revolving at $\frac{3}{8}$ inch

below leno screen; the lamp in the centre $\frac{1}{2}$ inch below the copper; the sealing-wax needle $\frac{7}{8}$ inch above screen. I shall, in this instance, only give the gradual progress of the mean position of the needle, as calculated from the observations.

Position of the mean point.
°
203
203.5
Lighted the lamp.
200
190.1
189.9
199.9
205.3
213.3
212.0
211.5
217.3
216.5
221.3
224.6

This experiment presents the same results as the preceding one; and shows, that the observed fact is not influenced by the eccentric position of the source of heat.

As the silver wire, from which the needles were suspended, had been unwound from a small cylinder, I thought it probable that it might be a little twisted; in which case it would, from the weight of the needle, untwist until counterbalanced by the elasticity of the wire. If, in these circumstances, heat were applied, it might happen that the elasticity of the wire would be altered, and consequently, from that circumstance alone, that the needle might change its position. If this were the case, on reversing the direction of rotation

of the plate, the torsion, which was previously supposed favourable for the reversed motion of the needle, would now act against it; I therefore made the following experiment.

Experiment 15.

The motion of the copper plate was reversed, and reading in the new direction, the following were the mean positions of the wax needle.

°
15.6
16.0
The lamp lighted.
15.0
Observation lost.
2.0
1.1
31.5
37.2
58.3
45.5
50.3

The greatest regression of the mean point of the needle was nearly 14°; so that if torsion had any influence on the former experiments, it was unfavourable to the production of the retrograde motion.

Experiment 16.

A screen of sheet zinc, about $\frac{1}{16}$ inch thick, was placed under a needle of sealing-wax, at about $\frac{7}{8}$ inch below it. The lamp was placed on the platform below, having its wick at the distance of about an inch from the zinc. The following observations were made.

Mean position of the needle.

°
249.0
249.25

Lamp lighted.

250.75
256.25
258.75
256.25
254.75
260.25
258.75
262.25
260.5
261.25
261.5
268.5

In this case, where a source of heat was revolving under a metal plate, the needle suspended above did not retrograde, but moved on in the same direction as the heat: the small comparative recession, at the sixth and seventh observation, not being of sufficient magnitude to be noticed, and it never having returned as far back as the point from which it started.

From this experiment it appears, that, whatever may be the cause of these movements, it does not arise from any vortex produced by the moving part of the apparatus, nor is it owing to the passage of any air through the screens.

In order to prove that no tremors arising from the moving power, and communicated through the solid parts of the apparatus, had produced these effects, the following experiment was made.

Experiment 17.

The apparatus being in precisely the same state as in the last experiment, the lamp was not lighted, and the following observations were registered.

Oscillation of wax needle.	Diff.	½ Diff.	Mean position.
0	0	0	
L ... 259 R ... 255	4	2	257
L ... 258.5 R ... 256	2.5	1.25	257.25
The apparatus was set in motion; the lamp revolving, but not being lighted.			
L ... 258.8 R ... 256	2.8	1.4	257.4
L ... 258.8 R ... 256.4	2.4	1.2	257.6
L ... 258.6 R ... 256.5	2.1	1.05	257.55
L ... 258.8 R ... 257.2	1.6	0.8	258
L ... 258.2 R ... 256.8	1.4	0.7	257.5
L ... 258.2			

This experiment clearly proves, both from the stationary position of the mean point, and from the decrease of the arc through which the needle oscillated, that no vibrations are communicated from the jack to the needle.

I now tried the effect of winding up the jack, and found that it did not increase the arc half a degree on each side, although it caused the needle and silver wire to oscillate slightly, as a pendulum.

Considering it possible, by means of an agate cap, to suspend the various needles employed in these experiments,

with sufficient delicacy to allow them to obey the minute forces under investigation, I made the following experiment.

Experiment 18.

A card of the same form and size as the brass needle described in Experiment 1, covered with sealing-wax, having an agate cap in its centre, was balanced on the point of a sewing needle, cemented to a glass bridge, which rested on the screen. The wax card was about 1.5 inches above the leno screen; under which, at the distance of .3 inch below, the copper plate was placed. The lamp was placed below the copper, at the distance of .75 inch from its edge. No motion was communicated to any part of the apparatus; the waxed card needle rested at 168°. The lamp was lighted, and at the end of 75″ the needle had moved 8°; it gradually advanced towards that part of the copper immediately above the lamp, and at the end of four minutes and a half became stationary at 87°.5, a point not precisely over the lamp, but a little on one side of it.

Experiment 19.

The same apparatus and relative distances being used, no motion was employed; a piece of red-hot iron, one inch long, by half an inch broad, was placed on the platform below the copper, instead of the lamp. The red-hot iron was placed under 210°, about one inch below the copper; and the waxed card needle rested at 143°. The experiment began at

$4^h\ 23^m$
4 28 no effect.
4 32

The nearest end of the needle had moved over 47°, to a spot

not quite above the edge of the hot iron, and about 10° from its centre.

In order to get rid of the electrical effect of the glass or wooden supports, which I have called bridges, and which sometimes supported the needles, I placed a cork on the centre of the screen, immediately above the centre of the copper disc; into this was fixed the point of a sewing needle, on which the agate caps of the needles rested. I conceived this arrangement necessary, because, when no screens were employed, and the distance between the needle and the revolving plate was considerable, it sometimes happened that the needle followed the copper in its motion until it came over the supporting bridge, where it sometimes rested, instead of continuing its revolutions as long as the copper plate was kept in motion.

Experiment 20.

Using a wax card needle supported by a cork placed over the centre of the leno screen, and the lamp placed in the centre, under the copper plate, a slow motion was given to the lamp and plate. After some minutes, the needle had receded in a direction contrary to that of the motion of the plate through 35°. This experiment was repeated several times, and I observed that the needle, (if it moved at all,) generally went in an opposite direction to the plate; and that its motion was often so slow as to be imperceptible to the eye, although it could be very distinctly perceived after the lapse of a short time, by its altered position. In various repetitions of this experiment, the needle slowly retrograded from 10 to 90 degrees.*

* In one experiment which lasted above half an hour, and in which I had the advantage of Mr. CHRISTIE's assistance, the needle slowly retrograded over 157°. In this case the motion was rather slower than that of the minute hand of a watch.

For the purpose of determining whether the air, heated by the upper surface of the metal disc, acted on the needles, as it does on the vane of a smoke-jack, I made the following experiment.

Experiment 21.

Having formed a needle of sheet brass, thinner and lighter than those hitherto employed, but of the same form, I bent the circular parts, at the extremities, in such a manner, that they formed angles with the longitudinal axis of the needle; one of about 5°, the other about 15°. This being balanced above the copper plate, the lamp was lighted below it, but no rotation was communicated to the apparatus. The needle soon began to acquire vibrations in a vertical plane; but after five minutes' exposure there was no perceptible rotation. I now bent the circular extremities of the needle so as to form angles of about 35° and 40°. On replacing it, and lighting the lamp, the needle moved about 23°, in a contrary direction to that which the impinging air ought to have produced; it then returned, and went on through several revolutions in the opposite direction. The needle employed in this experiment projected a little beyond the copper plate, and would therefore receive some of the heated air passing from the lamp along the under side of the plate, to which cause the vertical vibrations may perhaps be ascribed.

From this experiment it appears, that if the needles are made flat with ordinary care, rotation will not ensue from the action of the heated air.

I shall now briefly restate the various causes to which these rotations might be ascribed, and refer back to the experiments which refute each supposition.

1st. The various currents of air in the room could not produce an almost uniform result. Considerable care was taken not to move about more than was requisite, and the experiments were generally made after the apparatus had been left, and the room shut up for some hours previous. In all but the earliest experiments the cylindrical millboard cases, in which the needles were placed, effectually excluded all currents of air exterior to them.

2nd. The rotation of a current of air produced within the lower cylinder by the motion of the lamp, metal plate, and the wooden platform supporting them, would, if it produced any effect, tend to make the needle rotate in the same direction. But we have seen from many experiments, that when a muslin screen is interposed, the rotation at the commencement is in the opposite direction. Also in Experiments 18 and 19 there was no rotation given to the apparatus, and yet the needle advanced; and in Experiment 16 a sheet of zinc prevented the air set in motion in the lower cylinder from communicating with that in the upper.

3rd. That air driven through the screen was not the cause of these motions, appears from their taking place when the screen was impenetrable to it. In Experiment 9, where no electricity was employed, a rapid rotation was kept up during six minutes immediately under a gauze screen, and no motion was produced in the needle above it.

4th. Perhaps the most probable of these suppositions is, that the motions result from the effect of currents of air which rise from the surface of the heated metal disc: these will cause other lateral currents, arising from the cold air flowing in to supply the place of that which has been heated,

and has ascended. Such an hypothesis might explain Experiments 18 and 19, if, on measuring its influence, the cause were found sufficiently powerful; but it appears from Experiment 21, that when the needles are not visibly bent in the form of vanes, this cause is not sufficient to produce the effect, although it acts in the same direction. The heated air above a revolving plate will revolve in the same direction; and if it pass through the interstices of the muslin, it ought to impress motion in the same direction as the plate from which it rises. The heated air above the zinc screen had not this rotatory motion; and we have seen by experiment 21, that its vertical action was not sufficient to produce the effect.

In many of the experiments no heat was employed; and yet the same motions resulted, as is apparent by Experiments 5 and 6 for direct motions, and by Experiment 10 for the retrograde.

5th. Vibrations excited in the apparatus by the motion of the jack. This cause was decisively refuted by Experiment 17, in which they were measured, and found to be quite insensible. Also in Experiments 18 and 19 the apparatus was not in motion, yet the needles did move.

6th. The torsion of the silver wire to which the needles were attached. Until I had measured this torsion by reversing the direction of the moving plate, as in Experiment 15, I had some suspicion that the heat of the lamp might have altered the elasticity of the wire; and although I did not then see how the reverse motion could be well accounted for, yet I was desirous, if possible, of removing altogether this disturbing action. Some of the previous experiments in

which no heat was employed, and many of the subsequent ones in which no wire was used, effectually refute this supposition.

7th. The electricity of the bridge might be supposed to produce some of the motions.

It was more necessary to get rid of the action of this cause than of any of the others, because electricity, modified indeed by the circumstances under which it was placed, did, in my opinion, produce the whole of these curious phenomena. The action of the glass or wooden support was apparent, and is noticed in the remarks on the 19th Experiment; but as it was not employed in any of those experiments in which the balance of torsion was used, and as it was dismissed from several of the latter ones in which reversed motions of the needle appeared, they cannot be attributed to this cause.

8th. The bending of the wax needle.

The application of heat after some time altered the form of the wax needle; it sometimes became so soft as to bend by its own weight down to the graduated circle. This change, however, only took place at the latter part of the experiment in which it occurred, and the phenomena recorded usually appeared at a much earlier period, when if it had commenced the change was quite imperceptible. In those experiments in which heat was not employed this cause was absent; and in many of those in which it was applied, a needle of card, or of thin brass covered with sealing-wax, or a mixture of resin and shell lac, was used, in which no bending took place.

Having shown that none of the causes to which I have

alluded are common to all the experiments in which the phenomena occurred, I shall now offer that explanation of them which appears to me to be warranted by the observations that have been recorded in the preceding part of this paper. They naturally divide themselves into two classes. 1st. Those in which the motion communicated is in the same direction as that of the revolving plate. 2ndly. Those in which the motion of the needle is in a contrary direction to that of the plate.

The instances in which the needles employed followed the directions of the revolving plate are so numerous, and the extent of their motion so great, that no doubt can remain of the fact, and some of them may be repeated with a very simple apparatus. The circumstance of one of the bodies employed being generally an electric, such as wax, resin, glass, and of the increase of the observed motions when these were previously excited by friction, or by a change of temperature during the experiment, naturally points out electricity as the cause. It is indeed the only one common to all the cases detailed.

If it be admitted that induced electricity is neither acquired nor given up in an instant of time, then it necessarily follows, from the reasoning I have explained at the commencement of this paper, that such motions must arise.

2nd. The case of a retrograde motion is much more difficult of explanation. Its existence rests on measures of much smaller magnitude, and it is by no means so easily re-produced, requiring some delicacy both in the adjustment of the apparatus, and in the observations of the needle. I have myself observed it so frequently, as to have not the smallest

doubt of the fact. I have occasionally shown it to several friends although I have not in every instance succeeded in this.

To have omitted to state in this paper the fact of such a retrograde motion would have been uncandid, because it is one which is strongly opposed to all the reasoning that it contains. To abstain from giving any explanation, however imperfect, that might reconcile it with my view of the subject, would be to leave untouched a very powerful, and almost solitary argument against the explanation which I have proposed both of magnetic and electric rotation. I shall therefore attempt to show, not merely that it is not repugnant to the principle which I have already explained, but that that very principle may, in certain circumstances, produce the retrograde motion, and that in others nearly similar, it shall not take place; thus not merely showing the possibility of the fact, but accounting for its apparently capricious nature.

In figure 2, N represents the end of an excited needle, situated above a metal plate C, and having a muslin screen G interposed between them. All three being at rest, the screen and the metal plate will become electric by induction, and one of the two following arrangements must take place: either the electricity developed on the screen and on the plate will be of the same species, in which case it will be contrary to that of the needle N; or the electricity on the screen and the metal plate will be of different kinds, in which case one of them must be of the same species, the other of a different one from that of the needle.

In the first case let B B represent the curve of the intensity of induced electricity on the muslin screen, that is, let each of its ordinates be supposed proportional to the electricity at

the corresponding point on the screen; then, part of the influence of the electrified body N passing through the interstices of the screen, produces on the metal plate the same kind of electricity as it did on the screen. Let the curve of electric intensity in the metal plate be A. Whilst the metal plate C remains at rest, both its electricity and that of the screen tend to draw the needle N directly towards it; but if the plate C move in the direction of the arrow with an uniform velocity, and if induced electricity be not instantly annihilated, then there will arise a new electric equilibrium, and the curve representing its intensity and position will have advanced towards that part to which the motion is directed, and may be represented by the dotted line *a*. The influence of this electricity, which is of the same kind with that on the screen, and which consequently it repels, will be, that the electric curve on G must be driven back in the opposite direction: let it be represented by *b*, *b*. Now the attraction of *b*, *b* on the needle N tends to give it a motion in the direction contrary to that which is impressed on it by the attraction of *a*, which is on the opposite side of the perpendicular, dropped from N to the metal plate. That proportion of the resolved action of *b*, *b*, which communicates horizontal movement, is larger than it is at the greater distance of the plate C, and the whole force acts at a shorter distance: it may therefore exert a more powerful influence in turning the needle in that direction, than a stronger force at a greater distance, C acting more unfavourably. Thus the needle may, by the advance of the plate C, be caused to retrograde. It does not, however, follow, that this must always happen, for the susceptibility for induced magnetism in the plate may be much

greater, and it may retain it much longer than the screen, and in this case we ought to anticipate a motion of the needle in the same direction as the plate.

Let us now examine the case of one of the bodies possessing the same kind of electricity as the needle. Let the same letters in figure 2 represent the electricities when the plate is at rest; thus, when it moves in the direction of the arrow, the electric curve will assume the position of the dotted line *a;* and since it is of an opposite kind to that of the screen, it will attract it, and will tend to draw the electric curve B on the screen into the position *b*, *b*, marked by the dotted lines. In this case the electric forces are both on the same side of the perpendicular from the needle; but since they are of opposite kinds, one will attract, the other will repel the needle; and according to the strength of these forces, it will advance, be stationary, or recede. This explanation accords with the apparently capricious nature of the fact; the circumstances on which a direct or a retrograde motion depends are so numerous, and in the present state of our knowledge we have so few data for calculating their influence, that it is not surprising that the result of any given combination should be uncertain. Besides the relative distances, we ought to be acquainted with the relative conducting powers of the screen and plate,—the intensity which can be excited in each by a given inducing source—the quantity of that inducing action which can be transmitted through the interstices of the screen—the time each body takes to acquire and give up electricity—before we can attempt accurately to predict the result of any proposed arrangement.

There is another circumstance in which the above expla-

nation agrees well with the observed facts; since the motion communicated to the needle is the difference of two forces, each of which is very small, it must itself be smaller than either; and in case of any approach to equality in those opposing forces, it will become exceedingly minute.

With respect to the action of heat in encreasing these rotations, I am inclined to conjecture, that the distribution of electricity on the metallic plate is altered by the application of heat; that the part under the needle becoming electrified, produces in it induced electricity; and thus the plate being made to revolve, the rotation of the needle follows from the explanation previously given. It may, however, happen, that the wax needle becomes itself electric by the heat it receives from the plate below it.

It will naturally be enquired, whether a parallel to this retrograde motion cannot be produced with magnets. I have made a few trials with a plate of soft iron, an iron gauze screen, and neutralized magnets, but have not succeeded. I found the needles stationary over whatever point they were placed.

I shall conclude this paper with mentioning some of the methods by which I observed the angles passed over by the needles; this is the more necessary, because it was desirable to remove all the parts of the apparatus as far from them as could be conveniently done.

If the angle was small, a fine thread of glass was made to project from the end of the needle, and a lamp was placed in such a position as to throw its shadow on the graduations below; this of course would only do for the measure of a few degrees, and was inconvenient by day.

In some instances I used a plano-convex lens cut into halves, one half being fixed as much before the other as the distance of the needle from the graduations required; this brought the image of the glass thread and the graduations into the same plane; but as the lens I had cut was of too short focal length, this plan was not often adopted.

I occasionally employed a narrow ring of glass, on one half of which the graduated card circle was pasted; the back of the glass ring was blackened. By placing the eye above the needle in such a position that the direct image of the glass thread covered that which was reflected from the black glass, all parallax was avoided; and I found that, without great carelessness, repeated observations never differed more than a quarter of a degree.

Another method which I made use of was, to draw a fine line along the needle; and having made a small hole in the centre of the glass plate which covered the apparatus, I fixed an index of card, which could revolve about it as a centre; this index extended to a graduated circle fixed on the same glass cover. When I wished to observe the position of the needle, I brought one edge of the index to coincide with the line on the needle. There were some advantages in this method, but it had the inconvenience of obliging me to touch the apparatus at each observation.

XXXI. *Case of a lady born blind, who received sight at an advanced age by the formation of an artificial pupil. By* James Wardrop, *Esq. F. R. S. Edin. Surgeon Extraordinary to the King, &c. Communicated by the President.*

Read June 15, 1826.

As imperfections in the original structure of our organs of sense, which are remediable by art, are extremely rare, and as cases of successful operations on these organs essentially contribute to illustrate their functions, as well as to throw light on the operations and developement of the human mind, the following instance of vision being imparted to a lady born blind, by an operation at an advanced period of life, will, it is hoped, not be considered unworthy of being submitted to the consideration of the Royal Society.

The case, besides establishing the curious physiological fact, that the nerve of the eye can remain fit to receive the impressions of external objects, though totally excluded for a long series of years from the performance of that function, claims a much higher interest in a philosophical point of view; some of the facts here detailed confirming in a remarkable manner what Berkeley had predicated of "a man born blind being made to see," in the 79th Section of his "New Theory of Vision," published in the year 1709. He says, "a man born blind being made to see, would, at the first opening of his eyes, make very different judgements of the magnitude of objects intromitted by them from what

others do. He would not consider the ideas of sight with reference to, or as having any connection with the *idea* of touch." It may also be observed, that in the present case the blindness was more complete, and the period at which vision was acquired was much later in life, than in any instance which has hitherto been recorded.

The lady, whose case forms the subject of this paper, was observed, during the first months of her infancy, to have something peculiar in the appearance of her eyes, and an unusual groping manner, which made her parents suspect that she had defective vision. When about six months old, she was placed under the care of a Parisian oculist, who performed an operation on both her eyes, with a view to afford her sight. The operation on the right eye was, however, followed by violent inflammation, and a collapse of the eye-ball, thus causing a complete destruction of the organ of vision. The operation on the left eye, though equally unsuccessful in attaining its object, was not followed by any alteration in the form or size of the globe. From the account stated by her friends, it was impossible to form any correct notion of the state of her eyes previous to the operations which were performed. It seems, however, extremely probable that the blindness, which was attempted to be remedied, had been produced by congenital cataracts, and that these operations had for their object the removal of the opaque lenses.

From the above early period she had continued totally blind, being able merely to distinguish a very light from a very dark room, but without having the power to perceive even the situation of the window through which the light entered; though in sunshine or in bright moonlight, she

knew the direction from whence the light emanated. With regard therefore to the degree of sight, this lady was more completely blind than the boy in the celebrated case related by Mr. CHESELDEN, in the 35th volume of the Transactions of the Royal Society; for in that instance the boy knew black, white, and scarlet apart from one another; and when in a good light he had that degree of sight, which generally continues in an eye affected with cataract; whereas in this lady, the pupil being completely shut up, no light could reach the retina, except such rays as could pass through the substance of the iris.

When she was placed under my care she had reached her 46th year. The right eye-ball was collapsed, but the left retained its natural globular form. The cornea of this eye was transparent, except at one point near its circumference, where there was a linear opacity, which had probably been the cicatrix of the wound made during the operation in her infancy. The anterior chamber of the eye was of its natural capacity, but I could not distinguish any vestige of a pupil, some streaks of yellow lymph being deposited in an irregular manner over the central part of the iris. There was every reason to believe that the retina was sound; for though she could not perceive objects, nor had any notion of colours, yet the circumstance already mentioned of her being able to distinguish between a very light and a very dark chamber, and between a gloomy day and sunshine, rendered it probable that the nerve was in a sound and natural state. Under this impression, I thought that the restoration of her sight by making an artificial pupil was practicable, and certainly well worthy of a trial. Accordingly, on the 26th of January, I

introduced a very small needle through the cornea, passing it also through the centre of the iris; but I could not destroy any of the adhesions which had shut up the pupillar opening. After this operation she said she could distinguish more light, but she could perceive neither forms nor colours. The result of this first attempt justified the favourable views entertained of the state of the retina, and Mr. LAWRENCE, who at this time was consulted, coincided with me in this opinion.

On the 8th of February, a second operation was performed, which consisted in passing a sharp edged needle through the sclerotica, bringing its point through the iris into the anterior chamber, repassing it into the posterior chamber at a small distance, and then dividing the portion of iris thus included between the two perforations of the needle. Only a very slight inflammation followed,—the light became offensive to her,—she complained of its brightness, and was frequently observed trying to see her hands; but it was evident her vision was very imperfect; for although there was an incision made in the iris, some opaque matter lay behind this opening, which must have greatly obstructed the entrance of light.

On the 17th of February, a third operation was performed, which consisted in still further enlarging the opening in the iris, and in removing the opaque matter, by a needle introduced through the sclerotica. This was followed by a very slight degree of redness. The operation being performed at my house, she returned home in a carriage, with her eye covered only with a loose piece of silk, and the first thing she noticed was a hackney coach passing, when she exclaimed, "What is that large thing that has passed by us?" In the course of the evening she requested her brother to

show her his watch, concerning which she expressed much curiosity, and she looked at it a considerable time, holding it close to her eye. She was asked what she saw, and she said there was a dark and a bright side; she pointed to the hour of 12, and smiled. Her brother asked her if she saw any thing more? she replied, "Yes," and pointed to the hour of 6, and to the hands of the watch. She then looked at the chain and seals, and observed that one of the seals was bright, which was the case, being a solid piece of rock crystal. The following day I asked her to look again at the watch, which she refused to do, saying, that the light was offensive to her eye, and that she felt very stupid; meaning that she was much confused by the visible world thus for the first time opened to her. On the third day she observed the doors on the opposite side of the street, and asked if they were red, but they were in fact of an oak colour. In the evening she looked at her brother's face, and said that she saw his nose; he asked her to touch it, which she did; he then slipped a handkerchief over his face, and asked her to look again, when she playfully pulled it off, and asked, "What is that?"

On the sixth day, she told us that she saw better than she had done on any preceding day; "but I cannot tell what I do see; I am quite stupid." She seemed indeed bewildered from not being able to combine the knowledge acquired by the senses of touch and sight, and felt disappointed in not having the power of distinguishing at once by her eye, objects which she could so readily distinguish from one another by feeling them.

On the seventh day she took notice of the mistress of the

house in which she lodged, and observed that she was tall. She asked what the colour of her gown was? to which she was answered, that it was blue: "so is that thing on your head," she then observed; which was the case: "and your handkerchief, that is a different colour;" which was also correct. She added, "I see you pretty well, I think." The teacups and saucers underwent an examination: "what are they like?" her brother asked her. "I don't know," she replied; "they look very queer to me; but I can tell what they are in a minute when I touch them." She distinguished an orange on the chimney-piece, but could form no notion of what it was till she touched it. She seemed now to have become more cheerful, and entertained greater expectation of comfort from her admission into the visible world; and she was very sanguine that she would find her newly acquired faculty of more use to her when she returned home, where every thing was familiar to her.

On the eighth day, she asked her brother, when at dinner, "what he was helping himself to?" and when she was told it was a glass of port wine, she replied, "port wine is dark, and looks to me very ugly." She observed, when candles were brought into the room, her brother's face in the mirror, as well as that of a lady who was present; she also walked, for the first time without assistance, from her chair to a sopha which was on the opposite side of the room, and back again to the chair. When at tea, she took notice of the tray, observed the shining of the japan work, and asked "what the colour was round the edge?" she was told that it was yellow; upon which she remarked, "I will know that again."

On the ninth day she came down stairs to breakfast in

great spirits; she said to her brother, "I see you very well to-day;" and came up to him, and shook hands. She also observed a ticket on a window of a house on the opposite side of the street ("a lodging to let"); and her brother, to convince himself of her seeing it, took her to the window three several times, and to his surprise and gratification, she pointed it out to him distinctly on each trial.

She spent a great part of the eleventh day looking out of the window, and spoke very little.

On the twelfth day she was advised to walk out, which recommendation pleased her much. Mr. —— called on her, and she told him she felt quite happy. Her brother walked out with her as her guide, and took her twice round the piazzas of Covent-garden. She appeared much surprised, but apparently delighted; the clear blue sky first attracted her notice, and she said, "it is the prettiest thing I have ever seen yet, and equally pretty every time I turn round and look at it." She distinguished the street from the foot pavement distinctly, and stepped from one to the other like a person accustomed to the use of her eyes. Her great curiosity, and the manner in which she stared at the variety of objects, and pointed to them, exciting the observation of many by-standers, her brother soon conducted her home, much against her will.

On the thirteenth day nothing particular took place till tea-time, when she observed that there was a different tea-tray, and that it was not a pretty one, but had a dark border; which was a correct description. Her brother asked her to look in the mirror, and tell him if she saw his face in it? to which she answered, evidently disconcerted, "I see my own; let me go away."

She drove in a carriage, on the fourteenth day, four miles on the Wandsworth road; admired most the sky and the fields, noticed the trees, and likewise the river Thames as she crossed Vauxhall bridge. At this time it was bright sunshine, and she said something dazzled her when she looked on the water.

On the fifteenth day, being Sunday, she walked to a chapel at some distance, and now evidently saw more distinctly, but appeared more confused than when her sight was less perfect. The people passing on the pavement startled her; and once when a gentleman was going past her, who had a white waistcoat and a blue coat with yellow buttons, which the sunshine brought full in her view, she started so as to draw her brother, who was walking with her, off the pavement. She distinguished the clergyman moving his hands in the pulpit, and observed that he held something in them; this was a white handkerchief.

She went in a coach, on the sixteenth day, to pay a visit in a distant part of the town, and appeared much entertained with the bustle in the streets. On asking her how she saw on that day? she answered, "I see a great deal, if I could only tell what I do see; but surely I am very stupid."

Nothing particular took place on the seventeenth day; and when her brother asked her how she was? she replied, "I am well, and see better; but don't tease me with too many questions, till I have learned a little better how to make use of my eye. All that I can say is, that I am sure, from what I do see, a great change has taken place; but I cannot describe what I feel."

Eighteen days after the last operation had been performed, I attempted to ascertain by a few experiments her precise

notions of the colour, size, forms, position, motions and distances of external objects. As she could only see with one eye, nothing could be ascertained respecting the question of double vision. She evidently saw the difference of colours; that is, she received and was sensible of different impressions from different colours. When pieces of paper one and a half inch square, differently coloured, were presented to her, she not only distinguished them at once from one another, but gave a decided preference to some colours, liking yellow most, and then pale pink. It may be here mentioned, that when desirous of examining an object, she had considerable difficulty in directing her eye to it, and finding out its position, moving her hand as well as her eye in various directions, as a person when blind-folded, or in the dark, gropes with his hands for what he wishes to touch. She also distinguished a large from a small object, when they were both held up before her for comparison. She said she saw different forms in various objects which were shown to her. On asking what she meant by different forms, such as long, round and square, and desiring her to draw with her finger these forms on her other hand, and then presenting to her eye the respective forms, she pointed to them exactly: she not only distinguished small from large objects, but knew what was meant by above and below; to prove which, a figure drawn with ink was placed before her eye, having one end broad, and the other narrow, and she saw the positions as they really were, and not inverted. She could also perceive motions; for when a glass of water was placed on the table before her, on approaching her hand near it, it was moved quickly to a greater distance, upon which she immediately said, "You move it; you take it away."

She seemed to have the greatest difficulty in finding out the distance of any object; for when an object was held close to her eye, she would search for it by stretching her hand far beyond its position, while on other occasions she groped close to her own face, for a thing far removed from her.

She learned with facility the names of the different colours, and two days after the coloured papers had been shown to her, on coming into a room the colour of which was crimson, she observed that it was red. She also observed some pictures hanging on the red wall of the room in which she was sitting, distinguishing several small figures in them, but not knowing what they represented, and admiring the gilt frames. On the same day, she walked round the pond in the centre of St. James's square, and was pleased with the glistening of the sun's rays on the water, as well as with the blue sky and green shrubs, the colours of which she named correctly.

It may be here observed, that she had yet acquired by the use of her sight but very little knowledge of any forms, and was unable to apply the information gained by this new sense, and to compare it with what she had been accustomed to acquire by her sense of touch. When, therefore, the experiment was made of giving her a silver pencil case and a large key to examine with her hands; she discriminated and knew each distinctly; but when they were placed on the table, side by side, though she distinguished each with her eye, yet she could not tell which was the pencil case and which was the key.

Nothing farther occurred in the history of this lady's case worthy of notice till the twenty-fifth day after the operation. On that day she drove in a carriage for an hour in the Regent's Park, and on her way there seemed more amused than

usual, and asked more questions about the objects surrounding her, such as " What is that?" it is a soldier, she was answered; " and that, see! see!" these were candles of various colours at a tallow chandler's window. " Who is that, that has passed us just now?" it was a person on horseback: " but what is that on the pavement, red?" it was some ladies who wore red shawls. On going into the Park, she was asked what she saw particularly, or if she could guess what any of the objects were. " Oh yes," she replied, " there is the sky, that is the grass; yonder is water, and two white things;" which were two swans. On coming home along Piccadilly, the jewellers' shops seemed to surprise her much, and her expressions made those around her laugh heartily.

From this period till the time of her leaving London on the 31st of March, being forty-two days after the operation, she continued almost daily to gain more information of the visible world, but she had yet much to learn. She had acquired a pretty accurate notion of colours and their different shades and names; and when she came to pay me a farewell visit, she then wore a gown, the first of her own choice, with the light purple colour of which she seemed highly gratified, as well as with her cap, which was ornamented with red ribbons. She had not yet acquired any thing like an accurate knowledge of distance or of forms, and up to this period she continued to be very much confused with every object at which she looked. Neither was she yet able, without considerable difficulty and numerous fruitless trials, to direct her eye to an object; so that when she attempted to look at any thing, she turned her head in various directions, until her eye caught the object of which it was in search. She still entertained however the

same hope which she expressed soon after the operation, that when she got home her knowledge of external things would be more accurate and intelligible, and that when she came to look at those objects which had been so long familiar to her touch, the confusion which the multiplicity of external objects now caused, would in a great measure subside.

May, 1826.

Fig. 10.

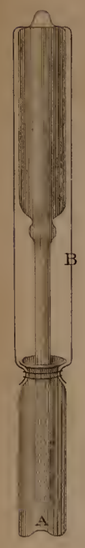


Fig. 4.

Fig. 11.

Fig. 5.

Fig. 2.

Fig. 3

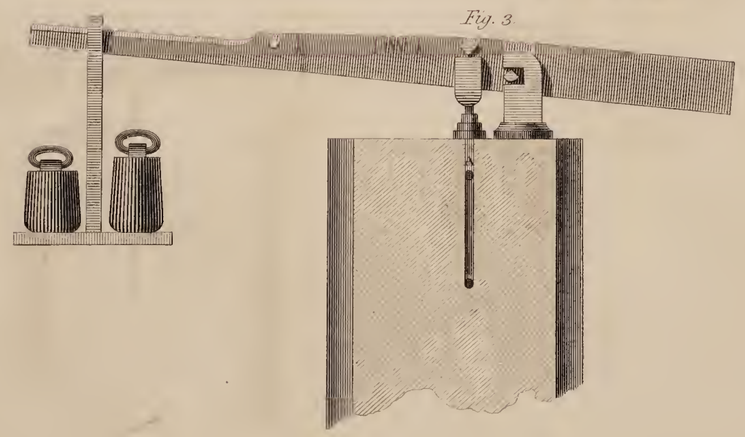


Fig. 6.

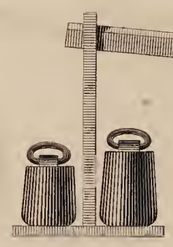


Fig. 1.

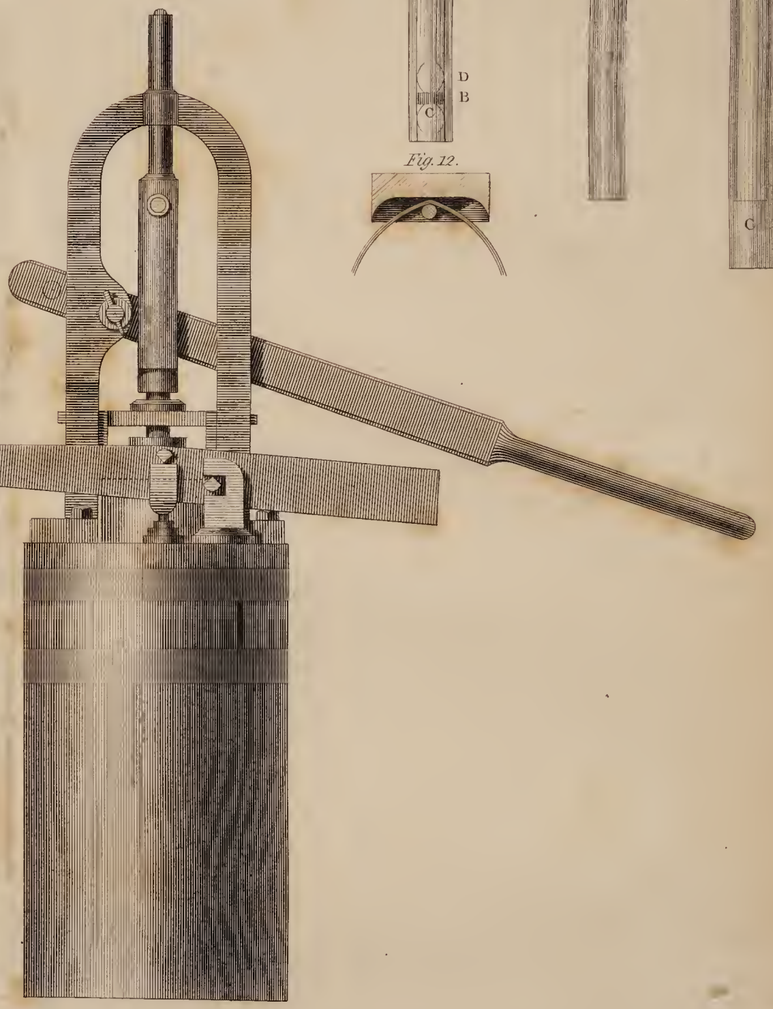


Fig. 7.

Fig. 12.

Fig. 9.

Fig. 8.

XXXII. *On the progressive compression of water by high degrees of force, with some trials of its effects on other fluids.* By J. PERKINS. *Communicated by* W. H. WOLLASTON, *M. D. V. P. R. S. May 25.*

Read June 15, 1826.

THE apparatus suggested by me in a paper read before the Royal Society the 22nd of June, 1820, on the compressibility of water, having now been completed, I will first describe its construction, and then give an account of the experiments already made with it.

Fig. 1. In the accompanying drawing, Plate XX. is a view of the compressing machine, and fig. 2 is a sectional view of the same, of which the following is a description. A, is a cylinder of gun metal, the length of which is 34 inches, and its external diameter $13\frac{1}{2}$ inches; B, is the receiver of the compressor, being $1\frac{1}{2}$ inch in diameter, and 29 inches long; C, is the barrel of a steel pump, $8\frac{1}{2}$ inches long and $1\frac{1}{4}$ inches diameter, on the outside of which a screw is cut 7 inches in length, by which it is finally united to the compressor; D, is the chamber or caliber of the pump, $\frac{5}{16}$ of an inch in diameter, and continuing of the same size throughout the whole length, excepting a conical enlargement at the bottom and top of the pump; the bottom cone receives the valve B when opening inwards; F, the piston or plunger of steel, most accurately fitted to the bore of the pump, having its lower extremity hollowed out to a semi-elliptical cup, with a very thin edge, the expansion of which during the

descent of the piston occasions it to be water-tight, without need of any stuffing. The lever G, which in this view passes behind the pump, is part of the apparatus for indicating the force of compression. Fig 3, represents a section of the indicator. A, is a cylindrical tube, communicating with the receiver of the compressor, and of such dimensions that its area is equal to $\frac{1}{14}$ of a square inch. Hence the number of pounds pressing on its piston by means of the lever G, indicates directly the number of atmospheres used for compression; since the arms of the lever are in proportion of 10 to 1, and its weight counterpoised by means of the hook O and weight, fig. 2, every pound in the scale represents 10 atmospheres of compressing force.

For the purpose of measuring the diminution of bulk that water undergoes, a glass piezometer, fig. 4, is used for containing it. This consists of an elongated bulb, nearly four inches in length and about $\frac{3}{4}$ of an inch in diameter, with a tube of regular bore, 9 inches long and about $\frac{1}{8}$ of an inch diameter internally. By weighing the quantity of quicksilver contained in this instrument when full, and ascertaining the weight contained in a given length of the tube alone, it was found that the whole content was equal to a tube of 190 inches long, having the diameter of the contracted part of the piezometer. Fig. 5, shows a section of the bottom of the piezometer, containing a small disk of steel D, and above it a delicate hair spring C, of sufficient strength to retain its position after being pressed upwards in the tube, so as to serve as register of the degree of compression that has been effected. Fig. 11, is a phial containing a small quantity of quicksilver, in which the piezometer, full of water, with its

register and disk, is to be inverted for experiment, as shown fig. 10.

The piezometer so arranged was then placed in the receiver of the compressor, which was filled with water, and kept at a temperature of 50 degrees FAHRENHEIT. The steel pump C, was next screwed firmly into its upper end, which is $\frac{1}{2}$ an inch longer than the screw or body of the pump, entering a recess of the cylinder of the compressor, of about $\frac{1}{4}$ of an inch in depth, which it exactly fitted. Between the head of the pump and the bottom of the recess was placed a collar of lead, for the purpose of making a more perfect joint.

The frame supporting the piston and pump handles was next screwed to the cylinder; about $\frac{1}{2}$ an inch of the upper end of the pump was bell-mouthed, the better to receive the piston, which rises quite out of the pump. Two desirable objects are effected by the piston leaving the chamber at each stroke, *viz.* 1st. It allows the water to fill the pump in the simplest manner; 2nd. The piston at each stroke receives a portion of the oil, which floats on the surface of the water in the cup M, which is of great consequence in high pressure. The piston F, contracts as it enters the bell mouth of the pump, which, together with the pressure of the water against the interior of the piston, causes it to fit as perfectly as the leather cup in the barrel of an air pump. All being ready, the pump was set to work, and as soon as the intended pressure was known to be effected by use of the valve, the pressure was gradually taken off, by unscrewing the pump C. The piezometer being removed from the compressor, the indicating spring was found raised in the tube, more or less, according to the power employed. The greatest amount

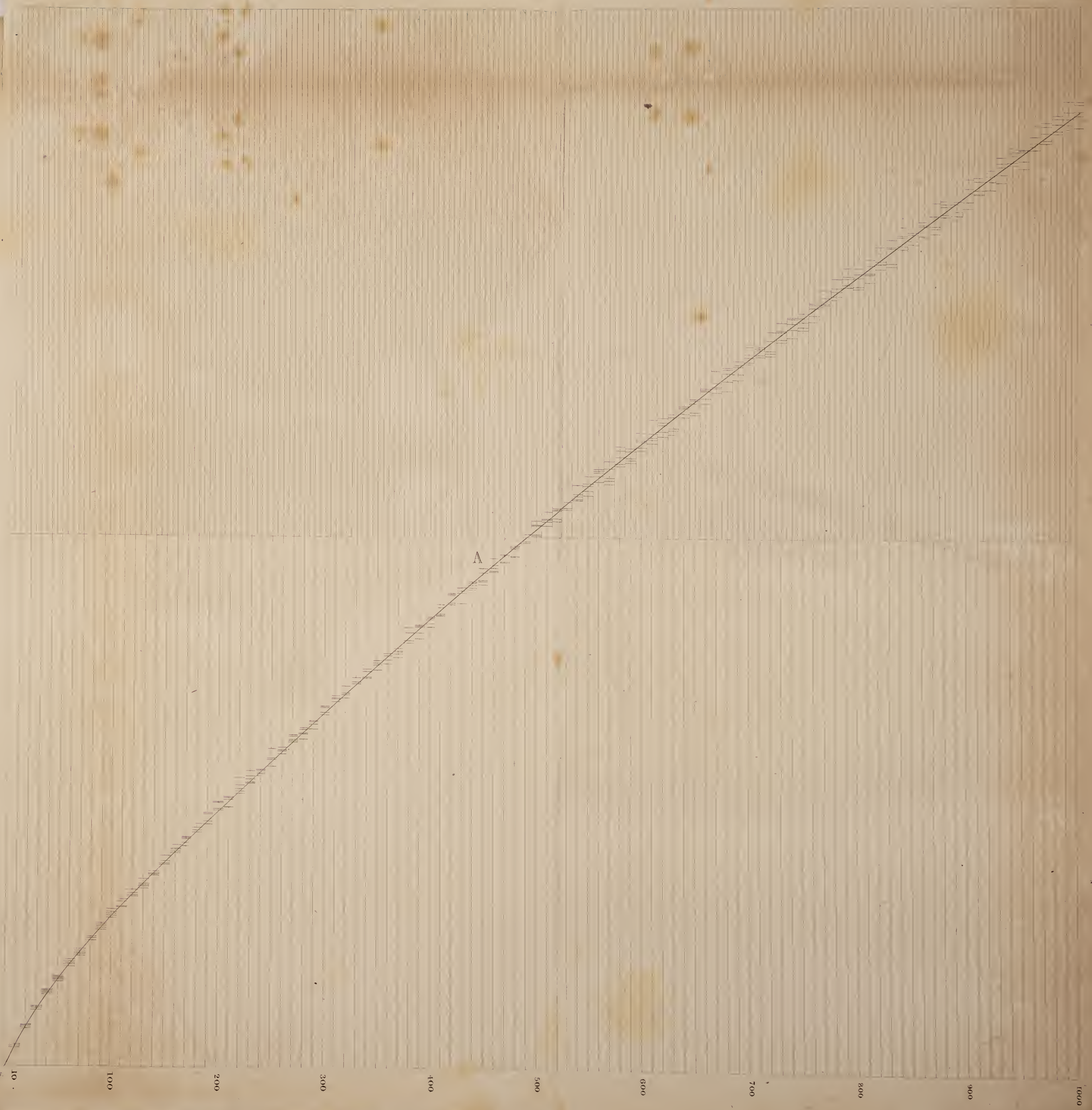
of which this apparatus admitted was 1000 atmospheres; being equal to 14,000 pounds to the square inch.

In order to estimate (though less accurately) higher degrees of compression, I had another piezometer, fig. 6, eight inches long, ground internally, perfectly cylindrical, and stopped at its upper extremity, with a flat disk of glass cemented into it. This tube I filled with water, and subjected it to a pressure of 2000 atmospheres. After repeating this experiment a great number of times, the average of the result showed that the column of water, 8 inches long, was compressed $\frac{2}{3}$ of an inch, or $\frac{1}{12}$ part of its length.

For the purpose of representing the law of condensation of water by different degrees of compressing force, I had a plate, 2, engraved, with parallel lines of $\frac{1}{10}$ of an inch a-part, to which the measure taken in each experiment was immediately transferred.

After the results of 5 experiments had been thus laid down for every 10 atmospheres, as far as 1000, a curve line has been drawn through the mean of them, as near as could be done to preserve a regular curve line. It may readily be seen, that there are various irregularities observable; but as the original records remain upon the plate, those who choose to theorize upon the subject, have the means of drawing any other curve that may suit their views of the true law of condensation.

With the same apparatus, I also made experiments on the compression of other fluids. The most remarkable result I obtained was with concentrated acetic acid; which, after compression with a force of 1100 atmospheres, was found to be beautifully crystallized, with the exception of about $\frac{1}{10}$ part of fluid, which, when poured out, was only slightly acid.


A
Atmospheres.
10
100
200
300
400
500
600
700
800
900
1000

I next applied the apparatus to the compression of aëriform fluids.

A gasometer B, was filled half full of water; it was then inverted, and placed in receiving tube A, as represented in fig. 8: it was found that, under a pressure of 500 atmospheres, the whole of the air was taken up by the water; but none of it was given out when the pressure was taken off.

As it might be supposed that even glass was pervious to water by such a force, a small phial was made air-tight, by fitting into its neck a well-ground glass stopper. It sustained pressure of 500 atmospheres without change, and was perfectly dry within, although it remained under that pressure 15 minutes. It was next subjected to a pressure of 800 atmospheres, and when taken out was found to be crushed to atoms.

In the course of my experiments on the compression of atmospheric air, by the same apparatus which had been used for compressing water, I observed a curious fact, which induced me to extend the experiment; *viz.* that of the air beginning to disappear at a pressure of 500 atmospheres, evidently by partial liquefaction, which is indicated by the quicksilver not settling down to a level with its surface. At an increased pressure of 600 atmospheres, the quicksilver was suspended about $\frac{1}{8}$ of the volume up the tube or gasometer; at 800 atmospheres, it remained about $\frac{1}{3}$ up the tube; at 1000 atmospheres, $\frac{2}{3}$ up the tube, and small globules of liquid began to form about the top of it; at 1200 atmospheres, the quicksilver remained $\frac{3}{4}$ up the tube, and a beautiful transparent liquid was seen on the surface of the quicksilver, in quantity about $\frac{1}{2000}$ part of the column of air. The gasometer, fig. 9,

was at another time charged with carburetted hydrogen, and placed in the receiving tube A, fig. 8, with its mouth immersed in the quicksilver C; it was subjected to different pressures, and it began to liquefy at about 40 atmospheres, and at 1200 atmospheres the whole was liquefied.

These instances of apparent condensation of gaseous fluids were first observed in January, 1822; but for want of chymical knowledge requisite to ascertain the exact nature of the liquids produced, I did not pursue the inquiry further; and as the subject has been taken up by those who are eminently qualified for the investigation, I need not regret my inability to make full advantage of the power I had the means of applying.

I have been desirous of ascertaining the law of condensation of gaseous fluids, at the high degrees of pressure; but as the apparatus for the compression of water, which requires to be made sensible at its lower extremity, is by no means adapted to show the higher degrees of compression of gases, a suitable apparatus requires to be made for such experiments; which I shall hope to make the subject of a future communication.

This Table shows, in inches and parts, the compression of a column of 190 inches of water, corresponding to every 10 atmospheres to 1000 inclusive.

Atmos.	Inches.	Inches.	Inches.	Inches.	Inches.	Atmos.	Inches.	Inches.	Inches.	Inches.	Inches.
10	0.176	0.191	0.200			510	5.110	5.147	5.170	5.180	5.241
20	0.350	0.367	0.380	0.390		520	5.150	5.270	5.255	5.267	5.280
30	0.522	0.540	0.550	0.560		530	5.260	5.275	5.340		
40	0.665	0.680	0.693	0.700	0.715	540	5.355	5.363	5.393	5.413	5.500
50	0.784	0.800	0.810	0.825	0.840	550	5.397	5.443	5.491	5.513	5.587
60	0.927	0.943	0.950	0.970	0.991	560	5.530	5.583	5.620	5.635	5.653
70	1.026	1.040	1.055	1.067	1.090	570	5.510	5.545	5.570	5.650	5.730
80	1.170	1.190	1.200			580	5.680	5.700	5.765	5.830	5.865
90	1.265	1.285	1.300	1.327	1.333	590	5.710	5.737	5.751	5.820	5.850
100	1.385	1.400	1.420	1.440	1.465	600	5.831	5.860	5.913	5.930	6.000
110	1.485	1.495	1.537	1.560		610	5.897	5.940	5.955	5.991	6.120
120	1.585	1.595	1.617	1.647		620	5.960	6.013	6.070	6.100	6.140
130	1.650	1.670	1.685	1.700	1.745	630	5.977	6.020	6.040	6.145	6.171
140	1.780	1.790	1.800	1.830		640	6.150	6.186	6.230	6.247	6.258
150	1.880	1.893	1.915	1.967		650	6.170	6.193	6.280	6.310	6.325
160	1.990	2.010	2.025	2.040	2.070	660	6.280	6.330	6.397	6.410	6.423
170	2.050	2.090	2.120	2.140	2.150	670	6.383	6.421	6.440	6.470	6.590
180	2.190	2.200	2.233	2.267		680	6.400	6.491	6.563	6.600	6.620
190	2.267	2.291	2.360	2.370		690	6.500	6.555	6.627	6.643	6.681
200	2.395	2.413	2.470	2.480		700	6.653	6.670	6.713	6.747	6.813
210	2.427	2.495	2.515	2 530		710	6.720	6.740	6.781	6.795	6.813
220	2.550	2.570	2.593	2.630	2.700	720	6.725	6.750	6.770	6.870	6.950
230	2.643	2.650	2.687	2.710	2.763	730	6.855	6.880	6.951	6.965	7.040
240	2.715	2.740	2.750	2.770	2.783	740	6.900	6.980	7.037	7.080	7.093
250	2.800	2.870	2.890	2.977		750	6.961	6.991	7.040	7.080	7.121
260	2.923	2.953	2.970	2.990		760	7.050	7.110	7.177	7.211	7.224
270	3.035	3.050	3.060	3.090	3.100	770	7.187	7.29	7.216	7.275	7.343
280	3.060	3.110	3.120	3.150	3.170	780	7.247	7.280	7.320	7.350	7.450
290	3.157	3.205	3.230	3.240		790	7.370	7.400	7.450	7.470	5.550
300	2.297	3.320	3.365	3.373		800	7.350	7.375	7.450	7.491	7.445
310	3.420	3 450	3.460	3.480		810	7.410	7.480	7.497	7.570	7.627
320	3.450	3.490	3.500	3.567		820	7.540	7.587	7.610	7.690	7.745
330	3.595	3.615	3.653			830	7.563	7.590	7.737	7.745	7.815
340	3.641	3.650	3.710	3.733	3.770	840	7.723	7.760	7.840	7.857	7.940
350	3.720	3.767	3.780	3 791	3.813	850	7.775	7.810	7.867	7.885	7.920
360	3.785	3.823	3.863	3 887		860	7.843	7.860	7.943	7.955	7.990
370	3.847	3.880	3 895	3.910	3.933	872	7.870	7.920	7.940	8.033	8.160
380	3.980	4.000	4.800	4.129		880	8.027	8.050	8.130	8.150	8.180
390	4.013	4.080	4.140	4.150	4.159	890	8.500	8 040	8.080	8.147	8.173
400	4.133	4.170	4.210	4.220	4.231	900	8.110	8.170	8.260	8.290	8.385
410	4.245	4.253	4.263	4.320	4.350	910	8.237	8.247	8.277	8.360	8.393
420	4.353	4.365	4.445	4.450	4.456	920	8.377	8.350	8.400	8.443	8.460
430	4.360	4.460	4.480	4.570	4.518	930	8.327	8.420	8.490	8.525	8 580
440	4.490	4.500	4.530	4.555	4.565	940	8.500	8,540	8.590	8.627	8.640 & 8.670
450	4.543	4.570	4.585	4.653	4.700	950	8.480	8.550	8.637	8.650	8.660
460	4.660	4.670	4.700	4.730	4.795	960	8.650	8 680	8.710	8.767	8.880
470	4.753	4.760	4.813	4.827	4.833	970	8.710	8.735	8.800	8.870	8.900
480	4 810	4.815	4.880	4.900	4.910	980	8.800	8.825	8.890	8.940	8.970
490	4.950	4.963	5 010	5.040		990	8.847	8.880	8.938	9.000	9.100
500	5.010	5.035	5.110	5.120	5.160	1000	8.855	8.973	9.005	9.076	9.100

It will appear, that at some pressures the result of only three or four experiments have been tabulated; this apparent omission arises from the entire coincidence of two or more of the experiments, and from my having omitted at the time to notice which were those which so agreed.

XXXIII. *On the figure of the earth.* *By* GEORGE BIDDELL AIRY, *M. A. Fellow of Trinity College, Cambridge. Communicated by* J. F. W. HERSCHEL, *Esq. Sec. R. S.*

Read June 15, 1826.

THE ellipticity of the earth, deduced by Captain SABINE from a series of pendulum experiments the most extensive, and apparently the most deserving of confidence, that has ever been made, differs considerably from that which, as is generally believed, is indicated by geodetic measures. The difference can only be explained by errors of observation, by peculiarities of local circumstances, or by some defect in the theory which connects the figure of the earth with the variation of gravity on its surface: under the last head may be placed defects in the mathematical part of the theory, and errors in the assumptions of the original constitution and present state of the earth. It was with a view to ascertain the sufficiency of the mathematical theory, that I undertook the investigations contained in this paper. The celebrated proposition called CLAIRAUT's theorem, by which the earth's ellipticity is inferred from the variation of gravity on its surface, is obtained only by the rejection of the squares and higher powers of the ellipticity. It is by the same rejection that the figure of the earth, supposed a heterogeneous fluid, is proved to be an elliptic spheroid. It appeared therefore probable, that a more accurate theory might introduce some modification into CLAIRAUT's theorem, and might also show

the figure of the earth to differ from an ellipsoid; and there was no reason to think that the first approximation to that figure was more accurate, than the first approximation to the motion of the moon's perigee. The result of my investigation does not at all serve to reconcile the pendulum observations made by Captain SABINE with the measures of degrees: and with respect to one object, which I hoped to obtain, I am therefore completely unsuccessful. The theory shows, however, that the earth's figure, on the usual suppositions as to its constitution, is not an elliptic spheroid; and the formulæ which I have obtained will give the means of determining very exactly the figure of the earth, when the experiments on the variation of gravity, or the measures of arcs on the earth's surface, shall be thought sufficiently accurate. As the subject is one whose interest is not confined to the present time, I have ventured to offer my investigations to the Royal Society.

The first part of the following sheets contains the theory of the heterogeneous earth, pushed so far as to include all the terms of the second order: it is succeeded by a comparison of this theory with Captain SABINE's results, and with the best arcs of the meridian that have been measured: and in the conclusion, I have offered some suggestions on the propriety of repeating some of these measures.

(1.) To ascertain the form of equilibrium of a fluid, it is first necessary to find the sum of the products of each particle by the reciprocal of its distance from any point of the fluid (LAPLACE, *Mecanique Celeste*, livre iii. nº. 23). This can be done only by assuming a function with indeterminate constants to represent the form of each stratum of equal

density: then finding that sum, and applying to it the conditions of equilibrium, the values of the constants will be found. As we propose to carry our approximation to the second order of the difference from a sphere, or the second order of the ratio of the centrifugal force to the force of gravity, it is evident that, without something to guide us, this will be a work of considerable labour.

(2.) Here, however, we shall derive some assistance from former investigations. CLAIRAUT and LAPLACE have shown that, to the first order, the form of every surface of equal density is an elliptic spheroid: the difference, consequently, of any surface of equal density from an elliptic spheroid is only of the second order. If a be the polar semi-axis of an elliptic spheroid, $a(1+e)$ the equatorial semi-axis, μ' the sine of the latitude of any point, (the latitude being that which is usually termed the corrected latitude), R the radius drawn to that point, then $R = a\left(1 + e.\overline{1-\mu'^2} - \frac{3e^2}{2}\overline{\mu'^2-\mu'^4}\right)$. The radius then of a surface of equal density is $a\left(1 + e.\overline{1-\mu'^2} - \frac{3e^2}{2}.\overline{\mu'^2-\mu'^4}\right)$ + a quantity of the second order. Now, upon using the elliptic value of R, it would be found that the equation of equilibrium could not be satisfied, in consequence of the appearance of μ'^4: but no higher powers of μ' would enter into that equation. To enable us to take away these terms, R must be increased by a function of μ', containing none but the even powers of μ' as far as μ'^4. The most convenient form that we can take is $a.A(\mu'^4-\mu'^2)$, since it vanishes both at the pole and at the equator, and at middle latitudes expresses the depression of the surface below the ellipsoid whose axes are the same. The value of R then

in the spheroidal surface of equal density is assumed to be $a\left(1+e.\overline{1-\mu'^2}-\left(\frac{3e^2}{2}+A\right).\overline{\mu'^2-\mu'^4}\right)$.

(3.) Let V be the sum of the products of each particle by the reciprocal of its distance from any point: let μ be the sine of the latitude of that point, r its distance from the centre: also let θ and ω be the latitude and longitude of that point, θ' and ω' those of any other point. Then it is easily found that their distance

$= \sqrt{\{r^2 - 2rR(\sin\theta.\sin\theta' + \cos\theta.\cos\theta'.\cos\overline{\omega'-\omega}) + R^2\}} =$
$\sqrt{\{r^2 - 2rR(\mu\mu' + \sqrt{1-\mu^2}\sqrt{1-\mu'^2}.\cos\overline{\omega'-\omega}) + R^2\}}$:
let this $= z$. Suppose now the heterogeneous spheroid divided into wedges by planes passing through the axis, and suppose each of these wedges divided into pyramids whose vertices are at the centre: let $\delta\omega'$ be the angle of two planes, and $\delta\theta'$ the angle made by the two surfaces of a pyramid which cut these planes; and suppose the pyramid divided into frustra, the length of one being δR. Then the solid content of this frustrum is ultimately $R\,\delta\theta'.R\cos\theta'\delta\omega'.\delta R = R^2\delta R.\delta\omega'.\delta\mu'$ ultimately; and if ρ be its density, the product of the particle into the reciprocal of its distance from the given point is ultimately $\frac{\rho.R^2\delta R.\delta\omega'.\delta\mu'}{z}$. Consequently, to find the sum of those products for the spheroid, we must integrate $\frac{\rho R^2}{z}$ with respect to R, ω', and μ': or, which amounts to the same, we must integrate $\frac{\rho R^2}{z}.\frac{dR}{da}$ with respect to a, ω', and μ': that is, we must take $\int_a\int_{\omega'}\int_{\mu'}\frac{\rho R^2}{z}.\frac{dR}{da}$*, or in

* I prefer this notation, as it does not necessarily carry with it the idea of infinitely small quantities.

the common notation $\iiint \frac{\rho R^2}{z} \cdot \frac{dR}{da} \cdot da \cdot d\omega' \cdot d\mu'$. The limits of μ' are -1 and $+1$: those of ω are 0 and 2π: and those of a are 0, and the value of a at the external surface, which we shall call a.

(4.) To perform these integrations, it is necessary to expand the expression for z in a series of powers of $\frac{R}{r}$ or $\frac{r}{R}$: the former of course must be used for the strata interior to the point in question, and the latter for the strata exterior to that point, that the series may in both cases converge. Suppose then $\frac{1}{\sqrt{\{r^2 - 2rR(\mu\mu' + \sqrt{1-\mu^2}\sqrt{1-\mu'^2}\cos(\omega'-\omega)) + R^2\}}} = \frac{Q^{(0)}}{r} + Q^{(1)} \cdot \frac{R}{r^2} + Q^{(2)} \cdot \frac{R^2}{r^3} + Q^{(3)} \cdot \frac{R^3}{r^4} +$ &c. for the former case, or $= \frac{Q^{(0)}}{R} + Q^{(1)} \cdot \frac{r}{R^2} + Q^{(2)} \cdot \frac{r^2}{R^3} + Q^{(3)} \cdot \frac{r^3}{R^4} +$ &c. for the latter, ($Q^{(0)}$, $Q^{(1)}$, $Q^{(2)}$, &c. being the same in both series): then $Q^{(i)}$ satisfies the following equation. (liv. iii. n°. 9)

$$0 = \frac{d}{d\mu}\left\{\overline{1-\mu^2} \cdot \frac{dQ^{(i)}}{d\mu}\right\} + \frac{1}{1-\mu^2} \cdot \frac{d^2Q^{(i)}}{d\omega^2} + i \cdot \overline{i+1} \cdot Q^{(i)}$$

which is likewise true if we put μ' for μ and ω' for ω. And the value of V now depends on the integral

$$\frac{1}{r^{i+1}} \int_a \int_{\omega'} \int_{\mu'} \rho \cdot Q^{(i)} \cdot R^{i+2} \cdot \frac{dR}{da} \text{ or } \frac{1}{r^{i+1}} \int_a \rho \int_{\omega'} \int_{\mu'} Q^{(i)} \cdot R^{i+2} \cdot \frac{dR}{da}$$

(since ρ is a function of a alone), for the interior strata, i being made successively $= 0, 1, 2, 3,$ &c.; and on the integral $r^i \int_a \rho \int_{\omega'} \int_{\mu'} \frac{Q^{(i)}}{R^{i-1}} \cdot \frac{dR}{da}$, for the exterior strata, i being made $= 0, 1, 2, 3,$ &c.

(5.) Suppose now R^{i+3} reduced into a series of the form

$B_o Z'^{(o)} + B_1 Z'^{(1)} + B_2 Z'^{(2)} +$ &c., where B_o, &c. are functions of a, and $Z'^{(k)}$ is a function of μ' that satisfies the equation

$$o = \frac{d}{d\mu'}\left\{\overline{1-\mu'^2}\cdot\frac{dZ'^{(k)}}{d\mu'}\right\} + k.\overline{k+1}.\,Z'^{(k)}$$

This equation is exactly similar to the equation above for $Q^{(i)}$, since R does not depend on $\omega' - \omega$, and therefore $\frac{d.^2 Z^{(k)}}{d\omega'^2}$ is $= o$. Then $R^{i+2}\cdot\frac{dR}{da} = \frac{1}{i+3}\cdot\frac{d.R^{i+3}}{da} = \frac{1}{i+3}\cdot\frac{d}{da}\left(B_o Z'^{(o)} + B_1 Z'^{(1)} + B_2 Z'^{(2)} + \text{&c.}\right)$, the general term of which is $\frac{1}{i+3}\cdot\frac{d.B_k}{da}\cdot Z'^{(k)}$ The value of V then for the interior strata is the sum of all the quantities

$$\frac{1}{(i+3).r^{i+1}}\int_a \rho\frac{d.B_k}{da}\int_{\omega'}\int_{\mu'} Q^{(i)}.\,Z'^{(k)}$$ upon giving to i and k the values o, 1, 2, 3, &c.; and the integral with respect to a must be taken from $a = o$ to $a =$ the value which it has in the stratum of equal density passing through the given point, which we shall call α.

(6.) For the strata exterior to the given point we must take the sum of the different values of $r^i\int_a \rho\int_{\omega'}\int_{\mu'}\frac{Q^{(i)}}{R^{i-1}}\cdot\frac{dR}{da}$. Now $\frac{1}{R^{i-1}}\cdot\frac{dR}{da} = \frac{1}{2-i}\cdot\frac{d}{da}\cdot\frac{1}{R^{i-2}}$, except $i = 2$, when $\frac{1}{R}\cdot\frac{dR}{da} = \frac{d}{da}\cdot$ log. R. Suppose then $\frac{1}{R^{i-2}}$ or R^{2-i} expanded into the series $b_o z'^{(o)} + b_1 z'^{(1)} + b_2 z'^{(2)}$, &c. where $z'^{(k)}$ satisfies the same equation as before; then for the value of V we must take the sum of all the quantities $\frac{r^i}{2-i}\int_a \rho\frac{d.b_k}{da}\cdot\int_{\omega'}\int_{\mu'} Q^{(i)}.z'^{(k)}$, upon giving to k the values

0, 1, 2, 3, &c. and to i the values 0, 1, 3, 4, &c. For the value $i = 2$, we must suppose log. R expanded into the series $c_0 y'^{(0)} + c_1 y'^{(1)} + c_2 y'^{(2)} +$ &c. and must take the sum of the quantities $r^3 \int_a \rho \frac{d \cdot c_k}{da} \int_{\omega'} \int_{\mu'} Q^{(2)} \cdot y'^{(k)}$, making k successively $= 0, 1, 2,$ &c. The integrals with respect to a must be taken from $a = \alpha$ to $a =$ a.

(7.) Now LAPLACE has shown (*Mec. Cel.* liv. 3. n°. 12). that $\int_{\omega'} \int_{\mu'} Q^{(i)} . Z'^{(k)}$ from $\mu' = -1$ to $\mu' = +1$, and from $\omega' = 0$ to $\omega' = 2\pi$, will always be $= 0$, except $k = i$. And it appears also (liv. 3. n°. 11.) that $U^{(i)} = \frac{4\alpha\pi}{2i+1} a^{i+3} . Y^{(i)}$; but $U^{(i)}$ (see n°. 17.) is there $= \alpha . a^{i+3} \int_{\omega'} \int_{\mu'} Q^{(i)} . Y'^{(i)}$ between the same limits, $Y^{(i)}$ being the value of $Y'^{(i)}$ when μ and ω are put for μ' and ω': hence $\int_{\omega'} \int_{\mu'} Q^{(i)} . Y'^{(i)} = \frac{4\pi}{2i+1} Y^{(i)}$, where $Y'^{(i)}$ is any function of μ' and ω' satisfying the equation $0 = \frac{d}{d\mu'} \left\{ \sqrt{1-\mu'^2} \cdot \frac{d . Y'^{(i)}}{d\mu'} \right\} + \frac{1}{1-\mu'^2} \cdot \frac{d^2 Y'^{(i)}}{d\omega'^2} + i . i+1 . Y'^{(i)}$. Consequently $\int_{\omega'} \int_{\mu'} Q^{(i)} . Z'^{(i)} = \frac{4\pi}{2i+1} Z^{(i)}$: $\int_{\omega'} \int_{\mu'} Q^{(i)} z'^{(i)} = \frac{4\pi}{2i+1} z^{(i)}$; and $\int_{\omega'} \int_{\mu'} Q^{(2)} . y'^{(2)} = \frac{4\pi}{5} y^{(2)}$ where $Z^{(i)}$, $z^{(i)}$, and $y^{(2)}$ are the values of $Z'^{(i)}$, $z'^{(i)}$, and $y'^{(2)}$, when μ' is changed to μ.

(8.) Since we propose to include only the second order of e, and since to that order no powers of μ' beyond the fourth are found in R or any function of R, it follows, that $Q^{(i)} Z'^{(4)}$ and $Q^{(i)} z'^{(4)}$ will be the last terms to be integrated,

and therefore i will not exceed 4. And as even powers only of μ' are found in R, there will be no terms as $Z'^{(i)}$ in which i is odd, and therefore it is not necessary to consider any but the even values of i. Now for the interior spheroids, when $i = 0$,

$$R^{i+3} = R^3 = a^3 \left\{ 1 + 3e.\overline{1-\mu'^2} + 3e^2.\overline{1-\mu'^2}^2 - (3A + \tfrac{9e^2}{2}).\overline{\mu'^2 - \mu'^4} \right\} :$$

and since by LAPLACE's formula (liv. 3. n°. 16), $Z'^{(i)}$, when it does not depend on ω', is a multiple of $\mu'^i - \frac{i.\overline{i-1}}{2.\overline{2i-1}}.\mu'^{i-2} + \frac{i.\overline{i-1}.\overline{i-2}.\overline{i-3}}{2.4.\overline{2i-1}.\overline{2i-3}}\mu'^{i-4}$ &c. we must resolve R^3 into multiples of $\mu'^4 - \frac{6}{7}\mu'^2 + \frac{3}{35}$, of $\mu'^2 - \frac{1}{3}$, and constants. Thus we have $R^3 =$

$$a^3(1 + 2e + e^2 - \tfrac{2}{5}A) - a^3(3e + \tfrac{57}{14}e^2 + \tfrac{3}{7}A)(\mu'^2 - \tfrac{1}{3}) + (\tfrac{15}{2}e^2 + 3A).(\mu'^4 - \tfrac{6}{7}\mu'^2 + \tfrac{3}{35})$$

whence $B_0 = a^3(1 + 2e + e^2 - \frac{2}{5}A)$, $Z^{(0)} = 1$.

Similarly when $i = 2$, $R^5 =$

a constant $- a^5(5e + \frac{25}{2}e^2 + \frac{5}{7}A)(\mu'^2 - \frac{1}{3})$ + a multiple of $(\mu'^4 - \frac{6}{7}\mu'^2 + \frac{3}{35})$:

whence $B_2 = -a^5(5e + \frac{25}{2}e^2 + \frac{5}{7}A)$, $Z^{(2)} = \mu^2 - \frac{1}{3}$.

And when $i = 4$, $R^7 =$

a constant + a multiple of $\overline{\mu'^2 - \frac{1}{3}} + a^7(\frac{63}{2}e^2 + 7A).(\mu'^4 - \frac{6}{7}\mu'^2 + \frac{3}{35})$:

whence $B_4 = a^7(\frac{63}{2}e^2 + 7A)$, $Z^{(4)} = \mu^4 - \frac{6}{7}\mu^2 + \frac{3}{35}$.

(9.) Collecting then the different terms of $\frac{1}{(i+3)r^{i+1}}\int_\alpha \rho \frac{dB_k}{da}\int_{\omega'}\int_{\mu'} Q^{(i)}.Z'^{(k)}$, which by (7) has no value except $k = i$, in which case $\int_{\omega'}\int_{\mu'} Q^{(i)}.Z'^{(k)} = \frac{4\pi}{2i+1}Z^{(i)}$, we

have V for the interior strata $= \frac{4\pi}{1\cdot 3\cdot r}\int_a \rho \frac{d\cdot a^3\left(1+2e+e^2-\frac{2}{5}A\right)}{da}$

$$-\frac{4\pi}{5\cdot 5\cdot r^3}\int_a \rho\cdot\frac{d\cdot a^5\left(5e+\frac{25}{2}e^2+\frac{5}{7}A\right)}{da}\left(\mu^2-\frac{1}{3}\right)+\frac{4\pi}{9\cdot 7\cdot r^5}\int_a \rho\frac{d\cdot a^7\left(\frac{63}{2}e^2+7A\right)}{da}\left(\mu^4-\frac{6}{7}\mu^2+\frac{3}{35}\right)$$

Let $\int_a \rho\frac{d\cdot a^3(1+2e+e^2-\frac{2}{5}A)}{da}=\varphi(a)$; $\int_a \rho\frac{d\cdot a^5(e+\frac{5}{2}e^2+\frac{1}{7}A)}{da}=\psi(a)$; $\int_a \rho\frac{d\cdot a^7(e^2+\frac{2}{9}A)}{da}=\upsilon(a)$, the integrals being made to vanish when $a=0$: taking them to $a=\alpha$, V for the interior strata $= \frac{4\pi}{3}\left\{\frac{\varphi(\alpha)}{r}-\frac{3}{5}\cdot\frac{\psi(\alpha)}{r^3}\cdot\overline{\mu^2-\frac{1}{3}}+\frac{3}{2}\cdot\frac{\upsilon(\alpha)}{r^5}\cdot\overline{\mu^4-\frac{6}{7}\mu^2+\frac{3}{35}}\right\}$

(10). For the strata exterior to the point in question, when $i=0$, $R^{2-i}=R^2$

$$=a^2\left(1+2e\cdot\overline{1-\mu^2}+e^2\cdot\overline{1-\mu^2}^2-(3e^2+2A)\cdot\overline{\mu^2-\mu^4}\right)$$

$$=a^2\left(1+\frac{4e}{3}+\frac{2e^2}{15}-\frac{4}{15}A\right)-a^2\left(2e+\frac{11}{7}e^2+\frac{2}{7}A\right)\cdot\overline{\mu^2-\frac{1}{3}}$$

$$+a^2(4e^2+2A)\cdot\overline{\mu^4-\frac{6}{7}\mu^2+\frac{3}{35}};$$

whence $b_0=a^2\left(1+\frac{4e}{3}+\frac{2e^2}{15}-\frac{4}{15}A\right)$, $z^{(0)}=1$.

When $i=2$, $\log R$

$$=\log a+e\cdot\overline{1-\mu^2}-\frac{e^2}{2}\cdot\overline{1-\mu^2}^2-\left(\frac{3e^2}{2}+A\right)\cdot\overline{\mu^2-\mu^4}$$

$$=\text{a constant term}-\left(e-\frac{5}{14}e^2+\frac{A}{7}\right)\cdot\overline{\mu^2-\frac{1}{3}}$$

$$+\text{a multiple of }\overline{\mu^4-\frac{6}{7}\mu^2+\frac{3}{35}};$$

whence $c_2=-\left(e-\frac{5}{14}e^2+\frac{A}{7}\right)$, $y^{(2)}=\mu^2-\frac{1}{3}$.

When $i=4$, $R^{2-i}=\frac{1}{R^2}$

$$=\frac{1}{a^2}\left(1-2e\cdot\overline{1-\mu^2}+3e^2\cdot\overline{1-\mu^2}^2+(3e^2+2A)\cdot\overline{\mu^2-\mu^4}\right)$$

$$=\text{a constant}+\text{a multiple of }\overline{\mu^2-\frac{1}{3}}-\frac{2A}{a^2}\cdot\overline{\mu^4-\frac{6}{7}\mu^2+\frac{3}{35}}$$

whence $b_4=-\frac{2A}{a^2}$, $z^{(4)}=\mu^4-\frac{6}{7}\mu^2+\frac{3}{35}$.

(11). Collecting the terms now in the same manner as in (9), according to the directions in (6), and observing the values of the integrals in (7), we find that part of V which depends on the exterior strata $= \frac{4\pi}{2.1}\int_a^{} \rho \frac{d.a^2\left(1+\frac{4e}{3}+\frac{2e^2}{15}-\frac{4}{15}A\right)}{da} -$

$\frac{4\pi}{5}r^2\int_a^{} \rho \frac{d\left(e-\frac{5}{14}e^2+\frac{A}{7}\right)}{da}\cdot\mu^2-\frac{1}{3}+\frac{4\pi}{2.9}r^4\int_a^{}\rho\cdot\frac{d\frac{A}{a^2}}{da}\cdot\mu^4-\frac{6}{7}\mu^2+\frac{3}{35}.$

Let $\int_a^{} \rho \frac{d.a^2\left(1+\frac{4e}{3}+\frac{2e^2}{15}-\frac{4}{15}A\right)}{da} = \tau(a)$; $\int_a^{} \rho \frac{d\left(e-\frac{5}{14}e^2+\frac{A}{7}\right)}{da} =$ $\chi(a)$; $\int_a^{}\rho\cdot\frac{d}{da}\cdot\frac{A}{a^2} = \sigma(a)$; then taking the integrals from $a = \alpha$ to $a =$ a we have for the exterior strata,

$$V=\frac{4\pi}{3}\left\{\frac{3}{2}\left\{\tau(a)-\tau(\alpha)\right\}-\frac{3}{5}r^2\left\{\chi(a)-\chi(\alpha)\right\}\mu^2-\frac{1}{3}\right.$$
$$\left.+\frac{r^4}{3}\left\{\sigma(a)-\sigma(\alpha)\right\}\mu^4-\frac{6}{7}\mu^2+\frac{3}{35}\right\}.$$

(12). Adding together the expressions in (9) and (11,) we find for the complete value of V, $\frac{4\pi}{3}\left\{\frac{\varphi(\alpha)}{r}+\frac{3}{2}\left\{\tau(a)-\tau(\alpha)\right\}+\right.$
$\left(\frac{\psi(\alpha)}{r^3}+r^2\left\{\chi(a)-\chi(\alpha)\right\}\right)\cdot\frac{1-3\mu^2}{5}+\left(\frac{v(\alpha)}{r^5}+\frac{2}{9}r^4\left\{\sigma(a)-\sigma(\alpha)\right\}\right)\cdot$
$\left.\left(\frac{9}{70}-\frac{9}{7}\mu^2+\frac{3}{2}\mu^4\right)\right\}$

(13.) When a fluid is in equilibrium,* if x, y, and z, be the co-ordinates of a point in it, and P, Q, R, the forces in those directions, then at a surface of equal density $P\delta x + Q\delta y + R\delta z = 0$ (liv. i. n°. 17); and the equilibrium is impossible except $P\delta x + Q\delta y + R\delta z$ be the complete variation of some function U. The equation then to a surface of equal density is $U = C$. In the present instance,

* I have not considered the second condition of equilibrium, given by Mr. Ivory in the Philosophical Transactions for 1824, as the reasoning upon which that Gentleman has founded the necessity of such a condition, appears to me altogether defective.

if the ordinates be measured from the centre, and x be the axis of revolution, and T the time of revolution, the only force besides the attraction is the centrifugal force; the resolved part of which in the direction of x is o, that in the direction of y is $\frac{4\pi^2}{T^2} y$, that in the direction of z is $\frac{4\pi^2}{T^2} z$. This contributes to δU the terms $\frac{4\pi^2}{T^2} (y\delta y + z\delta z)$, and to U the terms $\frac{2\pi^2}{T^2} (y^2 + z^2) = \frac{4\pi}{3} \cdot \frac{3\pi}{2T^2} r^2 \cdot \overline{1-\mu^2}$. And if δM be any attracting particle whose co-ordinates are x', y', z', its attractions in those directions are

$$\frac{(x'-x)\,\delta M}{(\overline{x'-x}^2 + \overline{y'-y}^2 + \overline{z'-z}^2)^{\frac{3}{2}}}, \quad \frac{(y'-y)\,\delta M}{(\overline{x'-x}^2 + \overline{y'-y}^2 + \overline{z'-z}^2)^{\frac{3}{2}}},$$

$$\frac{(z'-z)\,\delta M}{(\overline{x'-x}^2 + \overline{y'-y}^2 + \overline{z'-z}^2)^{\frac{3}{2}}}$$: and consequently it contributes to δU the term $\delta M \frac{(x'-x)\,\delta x + (y'-y)\,\delta y + (z'-z)\,\delta z}{(\overline{x'-x}^2 + \overline{y'-y}^2 + \overline{z'-z}^2)^{\frac{3}{2}}}$, and to U the term $\frac{\delta M}{\sqrt{(\overline{x'-x}^2 + \overline{y'-y}^2 + \overline{z'-z}^2)}}$. The expression then which the attraction of the whole adds to U is the sum of all the quantities $\frac{\delta M}{\sqrt{(\overline{x'-x}^2 + \overline{y'-y}^2 + \overline{z'-z}^2)}}$, or the sum of the products of each particle by the reciprocal of its distance from the attracted point; that is, V. The whole value of U then is $V + \frac{4\pi}{3} \cdot \frac{3\pi}{2T^2} \cdot r^2 \cdot \overline{1-\mu^2}$; and the equation to a surface of equal density is

$$C = \frac{4\pi}{3} \left\{ \frac{\varphi(\alpha)}{r} + \frac{3}{2} \{\tau(a) - \tau(\alpha)\} + \left(\frac{\psi(\alpha)}{r^3} + r^2 \{\chi(a) - \chi(\alpha)\} \right) \cdot \frac{1-3\mu^2}{5} + \frac{3\pi}{2T^2} r^2 \cdot \overline{1-\mu^2} + \left(\frac{v(\alpha)}{r^5} + \frac{2}{9} r^4 \{\sigma(a) - \sigma(\alpha)\} \right) \cdot \left(\frac{9}{70} - \frac{9}{7}\mu^2 + \frac{3}{2}\mu^4 \right) \right\}$$

(14.) If then for r we put its value in terms of the semi-axis of the spheroid which terminates it, and the angle which it makes with the equator, we shall have an equation which, so far as it depends on that angle, must be identically true.

Now if ε and E are the same functions of α which e and A are of a, $\frac{1}{r}$ to the second order $= \frac{1}{\alpha}\left(1 - \varepsilon \cdot \sqrt{1-\mu^2} + \varepsilon^2 \cdot 1 - \frac{\mu^2}{2} - \frac{\mu^4}{2} + \mathrm{E} \cdot \sqrt{\mu^2 - \mu^4}\right)$: $\frac{1}{r^3}$ to the first order $= \frac{1}{\alpha^3}(1 - 3\varepsilon \cdot \sqrt{1-\mu^2})$; $r^2 = \alpha^2(1 + 2\varepsilon \cdot \sqrt{1-\mu^2})$; $\frac{1}{r^5}$ including no small quantities $= \frac{1}{\alpha^5}$; $r^4 = \alpha^4$. These are not to be taken farther, because $\psi(\alpha)$, $\chi(\alpha)$, and $\frac{3\pi}{2T^2}$, are of the first order, and $\upsilon(\alpha)$ and $\sigma(\alpha)$ of the second order. Substituting these values in the last equation, we find C =

$$\left\{\begin{array}{l}
\frac{\varphi(\alpha)}{\alpha} + \frac{3}{2}\{\tau(a) - \tau(\alpha)\} \\
- \frac{\varepsilon\varphi(\alpha)}{\alpha} \cdot \sqrt{1-\mu^2} + \left(\frac{\psi(\alpha)}{\alpha^3} + \alpha^2\{\chi(a) - \chi(\alpha)\}\right) \cdot \frac{1-3\mu^2}{5} + \frac{3\pi}{2T^2}\alpha^2 \cdot \sqrt{1-\mu^2} \\
+ \frac{\varepsilon^2 \cdot \varphi(\alpha)}{\alpha} \cdot 1 - \frac{\mu^2}{2} - \frac{\mu^4}{2} + \frac{\mathrm{E}\varphi(\alpha)}{\alpha}\sqrt{\mu^2 - \mu^4} - \frac{3\varepsilon\psi(\alpha)}{\alpha^3} \cdot \sqrt{1-\mu^2} \cdot \frac{1-3\mu^2}{5} + \frac{3\pi}{2T^2} 2\varepsilon\alpha^2 \cdot \sqrt{1-\mu^2}^2 \\
+ 2\varepsilon\alpha^2\{\chi(a) - \chi(\alpha)\}\sqrt{1-\mu^2} \cdot \frac{1-3\mu^2}{5} + \left(\frac{\upsilon(\alpha)}{\alpha^5} + \frac{2}{9}\alpha^4\{\sigma(a) - \sigma(\alpha)\}\right) \cdot \left(\frac{9}{70} - \frac{9}{7}\mu^2 + \frac{3}{2}\mu^4\right.
\end{array}\right.$$

Making the coefficient of $\mu^2 = 0$, and that of $\mu^4 = 0$, and observing that, as the equations which we shall find are general for all values of α, we may put a for α,

$$0 = \left\{\begin{array}{l}
\frac{e\varphi(a)}{a} - \frac{3}{5} \cdot \frac{\psi(a)}{a^3} - \frac{3}{5}a^2\{\chi(a) - \chi(a)\} - \frac{3\pi}{2T^2}a^2 \\
- \frac{e^2\varphi(a)}{2a} + \frac{A \cdot \varphi(a)}{a} + \frac{12}{5} \cdot \frac{e\psi(a)}{a^3} - \frac{8}{5}ea^2\{\chi(a) - \chi(a)\} - \frac{3\pi}{2T^2}4ea^2 \\
\qquad - \frac{9}{7}\left(\frac{\upsilon(a)}{a^5} + \frac{2}{9}a^4\{\sigma(a) - \sigma(a)\}\right)
\end{array}\right.$$

$$0 = \left\{\begin{array}{l}
- \frac{e^2\varphi(a)}{2a} - \frac{A\varphi(a)}{a} - \frac{9}{5} \cdot \frac{e\psi(a)}{a^3} + \frac{6}{5}ea^2\{\chi(a) - \chi(a)\} + \frac{3\pi}{2T^2}2ea^2 \\
\qquad + \frac{3}{2}\left(\frac{\upsilon(a)}{a^5} + \frac{2}{9}a^4\{\sigma(a) - \sigma(a)\}\right)
\end{array}\right.$$

These are the equations of equilibrium; and since by differentiation they may be reduced to two differential equations, from which the two quantities A and e are to be found,

their solution is possible, and the equilibrium with the assumed figure is therefore possible.

(15.) At the surface these equations become

$$0 = \left(e - \frac{e^2}{2} + A\right)\frac{\varphi(a)}{a} - \left(\frac{3}{5} - \frac{12}{5}e\right)\cdot\frac{\psi(a)}{a^3} - \frac{3\pi}{T^2}a^3(1+4e) - \frac{9}{7}\cdot\frac{v(a)}{a^5}.$$

$$0 = -\left(\frac{e^2}{2} + A\right)\frac{\varphi(a)}{a} - \frac{9}{5}e\frac{\psi(a)}{a^3} + \frac{3\pi}{2T^2}2ea^2 + \frac{3}{2}\cdot\frac{v(a)}{a^3}.$$

(16). The force on any point in the direction of r is found by differentiating the expression at the end of (13) with respect to r. For since, by (13), the force in the direction of $x = \frac{dU}{dx}$, if we conceive x to coincide with r, the force in the direction of $r = \frac{dU}{dr}$. In this expression a is a function of r; but it will be found (as may also be proved by independent reasoning) that the terms produced by differentiation with respect to a destroy each other. The force then in the direction of r (with its sign changed, as we have to estimate not a repulsive but an attractive force) is

$$\frac{4\pi}{3}\left\{\frac{\varphi(a)}{r^2} - \left(-\frac{3\psi(a)}{r^4} + 2r\{\chi(a) - \chi(a)\}\right)\cdot\frac{1-3\mu^2}{5} - \frac{3\pi}{2T^2}\cdot 2r\cdot\overline{1-\mu^2}\right.$$
$$\left. - \left(-\frac{5v(a)}{r^6} + \frac{8}{9}r^3\{\sigma(a) - \sigma(a)\}\right)\cdot\left(\frac{9}{70} - \frac{9}{7}\mu^2 + \frac{3}{2}\mu^4\right)\right\}.$$

At the external surface this is $\frac{4\pi}{3}\left\{\frac{\varphi(a)}{r^2} + \frac{3}{5}\cdot\frac{\psi(a)}{r^4}\cdot\overline{1-3\mu^2}\right.$ $\left. - \frac{3\pi}{2T^2}\cdot 2r\cdot\overline{1-\mu^2} + \frac{v(a)}{r^6}\left(\frac{9}{14} - \frac{45}{7}\mu^2 + \frac{15}{2}\mu^4\right)\right\}$. Observing that $\frac{1}{r^2} = \frac{1}{a^2}\left(1 - 2e\cdot\overline{1-\mu^2} + 3e^2\,\overline{1-\mu^2} + 2A\cdot\overline{\mu^2-\mu^4}\right)$; $\frac{1}{r^4} = \frac{1}{a^4}\left(1 - 4e\cdot\overline{1-\mu^2}\right)$: $r = a\left(1 + e\cdot\overline{1-\mu^2}\right)$: $\frac{1}{r^6} = \frac{1}{a^6}$; the force on a point of the surface in the direction of

$$r = \frac{4\pi}{3}\left\{\frac{\varphi(a)}{a^2} - \frac{2e\cdot\varphi(a)}{a^2}\cdot\overline{1-\mu^2} + \frac{3}{5}\cdot\frac{\psi(a)}{a^4}\,\overline{1-3\mu^2}\right.$$
$$- \frac{3\pi}{2T^2}\cdot 2a\cdot\overline{1-\mu^2} + \frac{3e^2\cdot\varphi(a)}{a^2}\cdot\overline{1-\mu^2} + \frac{A2\cdot\varphi(a)}{a^2}\cdot\overline{\mu^2-\mu^4}$$
$$- \frac{12}{5}\cdot\frac{e\cdot\psi(a)}{a^4}\cdot\overline{1-\mu^2}\cdot\overline{1-3\mu^2} - \frac{3\pi}{2T^2}\cdot 2ea\cdot\overline{1-\mu^2}^2 + \frac{v(a)}{a^6}\left(\frac{9}{14} -\right.$$
$$\left.\left.\frac{45}{7}\mu^2 + \frac{15}{2}\mu^4\right)\right\}.$$

(17.) Now since this is the resolved part of the whole gravity at any point, which is necessarily perpendicular to the surface, we shall find the whole gravity by dividing this expression by the cosine of the angle of the vertical. To the order which we are considering, the angle of the vertical is the same in the spheroid and in the ellipsoid with the same axes, and it is therefore $= 2\,\underline{e}$. sin lat. cos lat. $= 2\,e\,.\,\mu\sqrt{1-\mu^2}$. Its cosine therefore $= 1 - 2\,e^2\,.\,\overline{\mu^2-\mu^4}$: consequently gravity at any point $= \frac{4\pi}{3}\left\{\frac{\varphi(a)}{(a)^2} - \frac{2e\,.\,\varphi(a)}{a^2}\,.\,\overline{1-\mu^2} + \frac{3}{5}\,.\,\frac{\psi(a)}{a^4}\,.\,\overline{1-3\mu^2} - \frac{3\pi}{2T^2}\,.\,2a\,.\,\overline{1-\mu^2} + \frac{2e^2\,.\,\varphi(a)}{a^2}\,.\,\overline{\mu^2-\mu^4} + \frac{3e^2\,.\,\varphi(a)}{a^2}\,.\,\overline{1-\mu^2} + \frac{2A\varphi(a)}{a^2}\,.\,\overline{\mu^2-\mu^4} - \frac{12}{5}\,.\,\frac{e\,.\,\psi(a)}{a^4}\,.\,\overline{1-\mu^2}\,.\,\overline{1-3\mu^2} - \frac{3\pi}{2T^2}\,.\,2\,e\,a\,.\,\overline{1-\mu^2}^2 + \frac{v(a)}{a^6}\left(\frac{9}{14} - \frac{45}{7}\mu^2 + \frac{15}{2}\mu^4\right)\right\}$. But this is in terms of μ, the sine of the corrected latitude: it will be more convenient to have it in terms of λ, the sine of the real latitude. Since the corr. lat. $=$ real lat. $- 2\,e$. sin. lat. cos. lat. it is easily found that $\mu^2 = \lambda^2 - 4\,e\,.\,\overline{\lambda^2-\lambda^4}$: substituting, gravity $= \frac{4\pi}{3}\left\{\frac{\varphi(a)}{a^2}(1 - 2\,e + 3\,e^2) + \frac{\psi(a)}{a^4}\left(\frac{3}{5} - \frac{12}{5}\,e\right) - \frac{3\pi}{2T^2}\,a\,(2 + 2\,e) + \frac{9}{14}\,.\,\frac{v(a)}{a^6} + \left(\frac{\varphi(a)}{a^2}(2\,e - 3\,e^2) - \frac{\psi(a)}{a^4}\left(\frac{9}{5} - \frac{12}{5}\,e\right) + \frac{3\pi}{2T^2}\,a\,(2 + 2\,e) + \frac{15}{4}\,.\,\frac{v(a)}{a^6}\right)\lambda^2 - \left(\frac{\varphi(a)}{a^2}(6\,e^2 - 2\,A) - \frac{72}{5}\,.\,\frac{e\,.\,\psi(a)}{a^4} + \frac{3\pi}{2T^2}\,6\,a\,e + \frac{15}{2}\,.\,\frac{v(a)}{a^6}\right)\,.\,\lambda^2\,.\,\overline{1-\lambda^2}\right\}$.

(18.) From the equations of (15), $\frac{\psi(a)}{a^4} = \frac{\varphi(a)}{a^2}\left(\frac{5\,e}{3} + \frac{5\,e^2}{6} + \frac{5\,A}{21}\right) - \frac{3\pi}{2T^2}\,a\left(\frac{5}{3} + \frac{130}{21}\,e\right)$; $\frac{v(a)}{a^6} = \frac{\varphi(a)}{a^2}\left(\frac{7\,e^2}{3} + \frac{2\,A}{3}\right) - \frac{3\pi}{2T^2}\,.\,\frac{10}{3}\,a\,e$. Substituting these, gravity

$= \frac{4\pi}{3}\left\{\frac{\varphi(a)}{a^2}\left(1 - e + e^2 + \frac{4\,A}{7}\right) - \frac{3\pi}{2T^2}\,a\,(3 + \frac{27}{7}\,e) + \left(\frac{\varphi(a)}{a^2}\,(-\,e + 2\,e^2 + \frac{2}{7}\,A) + \frac{3\pi}{2T^2}\,a\,(5 + \frac{39}{7}\,e)\right)\,.\,\lambda^2 - \left(\frac{\varphi(a)}{a^2}\,(-\,\frac{e^2}{2} + 3\,A) + \frac{3\pi}{2T^2}\,5\,a\,e\right)\,.\,\lambda^2\,.\,\overline{1-\lambda^2}\right\}$.

(19.) Let m be the ratio of the centrifugal force at the equator to gravity at the equator. The centrifugal force there $= \frac{4\pi^2}{T^2} a\,(1+e) = \frac{4\pi}{3} \cdot \frac{3\pi}{2T^2}\, 2a(1+e)$: the gravity there $= \frac{4\pi}{3}\left\{\frac{\varphi(a)}{a^2}(1-e) - \frac{3\pi}{2T^2} \cdot 3a\right\}$: therefore $\frac{3\pi}{2T^2} a\,(2+2e) = \frac{\varphi(a)}{a^2}(m - me) - \frac{3\pi}{2T^2} a \cdot 3m$; whence $\frac{3\pi}{2T^2} a = \frac{\varphi(a)}{a^2} \cdot \frac{m-me}{2+2e+3m} = \frac{\varphi(a)}{a^2}\left(\frac{m}{2} - me - \frac{3m^2}{4}\right)$. Making this substitution, gravity $= \frac{4\pi}{3} \cdot \frac{\varphi(a)}{a^2}\left\{(1-e-\frac{3}{2}m + e^2 + \frac{15}{14}me + \frac{9}{4}m^2 + \frac{4}{7}A) + \left(\frac{5m}{2} - e + 2e^2 - \frac{31}{14}me - \frac{15}{4}m^2 + \frac{2}{7}A\right)\lambda^2 - \left(\frac{5}{2}me - \frac{e^2}{2} + 3A\right) \cdot \lambda^2 \cdot \overline{1-\lambda^2}\right\}$ $= \frac{4\pi}{3} \cdot \frac{\varphi(a)}{a^2}\left(1 - e - \frac{3m}{2} + e^2 + \frac{15}{14}me + \frac{9}{4}m^2 + \frac{4}{7}A\right) \times \left\{1 + \left(\frac{5m}{2} - e + e^2 - \frac{17}{14}me + \frac{2}{7}A\right) \cdot \lambda^2 - \left(\frac{5}{2}me - \frac{e^2}{2} + 3A\right) \cdot \lambda^2 \cdot \overline{1-\lambda^2}\right\}$. If then the equatorial gravity be represented by G, the gravity in latitude l will be

$$G\left\{1 + \left(\frac{5m}{2} - e + e^2 - \frac{17}{14}me + \frac{2}{7}A\right)\sin.^2 l - \left(\frac{5}{2}me - \frac{e^2}{2} + 3A\right)\sin^2 l \cdot \cos^2 l\right\}$$

Whatever therefore be the law of density in the interior of the earth, the gravity at any point of the surface can be expressed from a knowledge of the form of that surface only. This is an extension of CLAIRAUT's theorem.

(20). We shall now proceed to find an expression for the length of an arc of the meridian included between two given latitudes. If θ be the corrected latitude, and $u = \frac{1}{r}$, the radius of curvature is $\frac{\left\{1 + \frac{1}{u^2} \cdot \left(\frac{du}{d\theta}\right)^2\right\}^{\frac{3}{2}}}{u + \frac{d^2u}{d\theta^2}}$. Here $u = \frac{1}{a}(1 - e.\overline{1-\mu^2} + e^2 \cdot \overline{1 - \frac{\mu^2}{2} - \frac{\mu^4}{2}} + A \cdot \overline{\mu^2 - \mu^4}) = \frac{1}{a}(1 - \frac{e}{a} + \frac{9e^2}{16} + \frac{A}{8} -$

$\left(\frac{e}{2} - \frac{e^2}{2}\right) \cos 2\theta - \left(\frac{e^2}{16} + \frac{A}{8}\right) \cos 4\theta\Big)$, and the radius of curvature $= a\left\{1 + \frac{e}{2} + \frac{25e^2}{16} - \frac{A}{8} - \frac{3e}{2} \cos 2\theta - \left(\frac{9e^2}{16} + \frac{15}{8} A\right) \cos 4\theta\right\}$.

Let this $= \gamma$. It was found that $\mu^2 = \lambda^2 - 4e \cdot \overline{\lambda^2 - \lambda^4}$, or $\sin^2 \theta = \sin^2 l - 4e \cdot \sin^2 l \cdot \cos^2 l$; from which $\cos 2\theta = \cos 2l + e - e \cos 4l$: hence $\gamma = a\left\{1 + \frac{e}{2} + \frac{e^2}{16} - \frac{A}{8} - \frac{3e}{2} \cos 2l + \left(\frac{15e^2}{16} - \frac{15}{8} A\right) \cos 4l\right\}$. Now since l is the angle made by the normal with a fixed line, the increment of the arc, corresponding to the increment δl of the latitude, is ultimately $\gamma \delta l$, and the arc $= \int_l \gamma$; integrating therefore from $l = L$ to $l = L'$, and making $a\left(1 + \frac{e}{2} + \frac{e^2}{16} - \frac{A}{8}\right) = R$, the arc included between the latitudes L and L′ =

$$R\left\{L' - L - \left(\frac{3e}{4} - \frac{3e^2}{8}\right) \cdot (\sin 2L' - \sin 2L) + \left(\frac{15e^2}{64} - \frac{15A}{32}\right) \cdot (\sin 4L' - \sin 4L)\right\}.$$

(21.) An arc of a parallel in latitude l, comprehending the difference of longitude D, is most easily obtained by observing that the decrement of its radius upon increasing l is equal to $\sin l \times$ the increment of the arc $= \sin l \times \gamma \delta l$, and therefore the radius $= -\int_l \gamma \sin l$; the integral being corrected so as to become o when $l = 90°$. We must therefore integrate $-R \sin l \left\{1 - \left(\frac{3e}{2} - \frac{3e^2}{4}\right) \cos 2l + \left(\frac{15e^2}{16} - \frac{15A}{8}\right) \cos 4l\right\}$. This gives the radius of the parallel $= R\left\{\left(1 + \frac{3e}{4} - \frac{3e^2}{8}\right) \cos l - \left(\frac{e}{4} + \frac{e^2}{32} - \frac{5A}{16}\right) \cos 3l + \left(\frac{3e^2}{32} - \frac{3A}{16}\right) \cos 5l\right\}$; and therefore the arc corresponding to the difference of longitude

$$D = D.R.\left\{\left(1+\frac{3e}{4}-\frac{3e^2}{8}\right)\cos l-\left(\frac{e}{4}+\frac{e^2}{32}-\frac{5A}{16}\right)\cos 3l + \left(\frac{3}{32}e^2-\frac{3A}{16}\right)\cos 5l\right\}.$$

I now proceed to compare this theory with observation. In selecting from the numerous determinations of the variation of gravity one set for our present purpose, there can be no hesitation in fixing on Captain SABINE's, as extending over the greatest arc of latitude, and as being made by the same observer with the same instruments at no great interval of time. The following are the places of his observations and their latitudes, with the lengths of the seconds' pendulum determined by him.

Place.	Latitude.	Length of seconds' pendulum in inches.
	° ′ ″	
St. Thomas .	24 41,2	39,02074
Maranham .	2 31 43,3	,01214
Ascension .	7 55 47,8	,02410
Sierra Leone .	8 29 27,9	,01997
Trinidad . .	10 38 56	,01884
Bahia . . .	12 59 21	,02425
Jamaica . .	17 56 7,6	,03510
New York .	40 42 43,2	,10168
London . .	51 31 8,4	,13929
Drontheim .	63 25 54,2	,17456
Hammerfest .	70 40 5,3	,19519
Greenland .	74 32 18,6	,20335
Spitzbergen .	79 49 57,8	,21469

The irregularities in the lengths at the places nearest to the equator are considerable; but the number of these places is so great, that the errors will probably destroy each other. Assuming the length of the seconds' pendulum = M + N cos 2 lat + P cos 4 lat. the errors are

$$-39{,}02074 + M + N \times {,}99989 + P \times {,}99959$$
$$-39{,}01214 + M + N \times {,}99610 + P \times {,}98445$$
$$-39{,}02410 + M + N \times {,}96194 + P \times {,}85063$$
$$-39{,}01997 + M + N \times {,}95640 + P \times {,}82938$$
$$-39{,}01884 + M + N \times {,}93171 + P \times {,}73611$$
$$-39{,}02425 + M + N \times {,}89895 + P \times {,}61626$$
$$-39{,}03510 + M + N \times {,}81034 + P \times {,}31330$$
$$-39{,}10168 + M + N \times {,}14910 - P \times {,}95552$$
$$-39{,}13929 + M - N \times {,}22559 - P \times {,}89821$$
$$-39{,}17456 + M - N \times {,}59992 - P \times {,}28024$$
$$-39{,}19519 + M - N \times {,}78082 + P \times {,}21936$$
$$-39{,}20335 + M - N \times {,}85784 + P \times {,}47184$$
$$-39{,}21469 + M - N \times {,}93767 + P \times {,}75849$$

To determine M, N, and P, by the method of least squares, we must form three equations, by making equal to nothing the sum of these errors—first, when each is multiplied by the coefficient of M in that line, then when each is multiplied by the coefficient of N, and finally when each is multiplied by the coefficient of P. Thus we find

$$0 = -508{,}18390 + M \times 13 + N \times 3{,}30259 + P \times 4{,}64544$$
$$0 = -128{,}29476 + M \times 3{,}30259 + N \times 8{,}82265 + P \times 4{,}02629$$
$$0 = -181{,}31213 + M \times 4{,}64544 + N \times 4{,}02629 + P \times 7{,}04391$$

By the solution of these equations M = 39,11647: N = −,10146; P = ,00106; and the length of the seconds' pendulum in inches = 39,11647 −,10146 × cos 2 lat + ,00106

$\times \cos 4$ lat $= 39{,}01606 + {,}20292 \times \sin^2$ lat $- 00844 \times \sin^2$ lat . $\cos^2$ lat . $= 39{,}01606 \{1 + {,}005201 \times \sin^2$ lat $- {,}000216 \times \sin^2$ lat . $\cos^2$ lat$\}$; and gravity is proportional to this. Comparing the coefficients of $\sin^2$ lat and $\sin^2$ lat . $\cos^2$ lat with those in the expression of Art. 19, we have the following equations

$$\frac{5m}{2} - e + e^2 - \frac{17}{14} m e + \frac{2}{7} A = {,}005201$$

$$\frac{5}{2} m e - \frac{e^2}{2} + 3 A = {,}000216$$

From the length of the equatorial pendulum, supposing the equatorial radius of the earth $=$ 3486908 fathoms, we find $m = {,}003464$. And in the terms of the second order instead of e we may put $\frac{1}{290}$, which is certainly not far from the truth. Making these substitutions, the equations become

$${,}008657 - e + \frac{2}{7} A = {,}005201$$

$${,}000024 + 3 A = {,}000216$$

From these, $e = {,}003474 = \frac{1}{287{,}8}$; and $A = 000064$. The sign of A shows that the earth is less protuberant at the latitude of 45° than an ellipsoid of the same polar and equatorial radii. For the elevation of the spheroid above the ellipsoid $= a A . \mu^2 . \overline{\mu^2 - 1}$, where $\mu =$ sine of latitude; making the latitude $= 45°$, $\mu = \frac{1}{\sqrt{2}}$, and the elevation of the spheroid is $- \frac{A}{4}$: as A here is positive, this elevation is negative, or the spheroid at that latitude is depressed below the ellipsoid. This I should be inclined to expect: for though I have not been able to solve the differential equation in *A*, even in the cases in which the differential equation for *e* can

be solved to the first order, yet by the examination of a simple hypothesis (that of a homogeneous fluid whose density is very small surrounding a central nucleus), it may easily be seen that in this case the spheroid is not so far protuberant in middle latitudes as the ellipsoid. If the attraction of the fluid be neglected, and the central mass be called m, the force on any point in the direction of $x = \frac{-mx}{(x^2+y^2+z^2)^{\frac{3}{2}}}$: that in the direction of $y = \frac{-my}{(x^2+y^2+z^2)^{\frac{3}{2}}} + \frac{4\pi^2}{T^2}y$; that in $z = \frac{-mz}{(x^2+y^2+z^2)^{\frac{3}{2}}} + \frac{4\pi^2}{T^2}z$. Hence $U = \frac{m}{\sqrt{(x^2+y^2+z^2)}} + \frac{2\pi^2}{T^2}\overline{y^2+z^2} = C$; or if $y^2+z^2 = v^2$, $\frac{m}{\sqrt{x^2+v^2}} + \frac{2\pi^2}{T^2}v^2 = C$; whence $x^2 = \frac{m^2}{\left(c - \frac{2\pi^2}{T^2}v^2\right)^2} - v^2 = \frac{m^2}{C^2} - \left(1 - \frac{4\pi^2 m^2}{C^3 T^2}\right)v^2 + \frac{6\pi^4 m^2}{C^4 T^4}v^4$ nearly, supposing $\frac{2\pi^2}{CT^2}$ small; and this may be put under the form $(a^2 - v^2)(n - p\,v^2)$, from which the proposition is evident. I conclude therefore that the results of Captain SABINE's observations, as far as they go, are in strict agreement with theory.

I now come to the comparison of the expression for the length of a meridian arc with those arcs which have been most accurately measured. The influence of local circumstances on these measures, it is well known, is greater than that on pendulum experiments; and the discordances in different measures are such that, in order to get a result of any exactness, we must confine ourselves to the longest arcs which have been measured with the greatest care. I have selected the following: 1. BOUGUER's arc in Peru: 2. LAMBTON's whole arc in India: 3. The French arc from Formentera to

Dunkirk: 4. The English arc from Dunnose to Clifton: 5. The Swedish arc from Mallorn to Pahtavara.

The Peruvian arc I have taken as recalculated by DELAMBRE in the Base du Systeme Metrique, Tome iii. p. 112, &c. I have supposed the toise of Peru equal to 1,065766 fathoms.

The Indian arc is taken as finally corrected by Colonel LAMBTON in the Philosophical Transactions for 1823.

In the estimation of the length of a part of the French arc, which Colonel LAMBTON has given in the Philosophical Transactions for 1818, and which Captain KATER has sanctioned by copying without any remark, there appears to be a serious error, arising from an unnecessary reduction for temperature. As I am sensible that I am now opposed to two Gentlemen whose assertion on such a point is almost decisive, I will state distinctly the reasons which have led me to this conclusion.

In the measure of the base at Melun (Base du Systeme Metrique, Tome ii. p. 44), the length of the base was reduced to the length which it would have had if the measuring rods had been used at the temperature of 13° of REAUMUR, or $16°\frac{1}{4}$ centigrade. The number of rods employed was four; but the rod or module No. 1 was compared with each of the others, and the base was expressed by the length of the module No. 1 at the temperature of $16°\frac{1}{4}$ centigrade.

From the logarithm set down in p. 698, it appears that this was the length used in the calculation of the triangles.

The module No. 1 was found at this temperature to be less than two toises (the toise being the length of an iron standard, called the toise of Peru, at the temperature of 13° of REAUMUR); but from an error in the zero point of the metallic thermo-

meters there were some errors in the reduction of the base, which exactly corrected the difference (Tome iii. p. 136). The semi-module, therefore, in the expression for the arc of the meridian, is exactly equal to the toise of Peru at the temperature of $16^{\circ}\frac{1}{4}$ centigrade.

The standard mètre at the temperature of 0° centigrade = 443,296 lines of the toise of Peru at $16^{\circ}\frac{1}{4}$ centigrade (p. 139).

The standard mètre at the temperature of 0° centigrade was found by Captain KATER (Philosophical Transactions 1818) to be = 39,37079 inches of the English standard at the temperature of 62° Fahrenheit.

Consequently the semi-module in the expression for the arc of the meridian is = 1,065766 fathoms measured by the English standard at the temperature of 62° FAHRENHEIT; and since the English and Indian measures are estimated by this standard at the same temperature, no reduction is to be made for temperature. (The degree between Paris and Evaux is found thus to be 60822,5 fathoms; Col. LAMBTON has stated it to be 60779 fathoms). The length of the French arc given below, in fathoms, is therefore found by merely multiplying the number of semi-modules by 1,065766.

The English arc has the corrections which Captain KATER has given in the Phil. Trans. for 1821.

The Swedish arc is taken from SVANBERG's Exposition des Operations, &c. supposing their standard compared with the French standard at the temperature of 0° centigrade.

Thus the following table is formed.

Place.	L	L″	Length in Fathoms.
	° ′ ″	° ′ ″	
Peru . .	−0 2 31,22	3 4 31,9	188510
India . .	8 9 38,39	18 3 23,6	598630
France . .	38 39 56,11	51 2 9,2	751567
England .	50 37 5,27	53 27 29,89	172751
Sweden .	65 31 30,27	67 8 49,55	98870

In the application of the method of least squares, it must be observed, that the accuracy of the terrestrial measures can scarcely be questioned, and that the chance of errors in the determination of the extreme latitudes, arising either from faults of observation or from local attractions, is principally to be considered. This however amounts to the same as supposing an error in the length of the meridian arc. Assuming the form, M × number of seconds in $\overline{L'-L}$ + N (sin 2 L′ − sin 2 L) + P (sin 4 L′ − sin 4 L), the errors in the lengths are

$$-188510 + M \times 11223{,}1 + N \times {,}1086 + P \times {,}216$$
$$-598630 + M \times 35625{,}2 + N \times {,}3084 + P \times {,}412$$
$$-751567 + M \times 44533{,}1 + N \times {,}0023 - P \times {,}837$$
$$-172751 + M \times 10224{,}6 - N \times {,}0241 - P \times {,}175$$
$$-98870 + M \times 5839{,}3 - N \times {,}0383 - P \times {,}009$$

and the equations formed in the same manner as before are

$$0 = -59255232 + M \times 3516949{,}8 + N \times 11{,}8382 - P \times 22{,}016$$
$$0 = -198869 + M \times 11838{,}2 + N \times {,}1090 + P \times {,}153$$
$$0 = 37285 - M \times 2201{,}6 + N \times {,}0153 + P \times {,}093$$

from which M = 16,88164; N = −9358; P = 267; and the length of an arc of the meridian in fathoms =

$16{,}88164 \times$ n°. of seconds in $\overline{L' - L} - 9358 \times (\sin 2\,L' - \sin 2\,L) + 267 \times (\sin 4\,L' - \sin 4\,L)$.

The lengths of the several arcs found from this expression differ from those above by -4, $+4$, -19, $+35$, and $+63$ fathoms respectively. The largest of these errors falls (as will generally be the case when the method of least squares is used) on that length in which the coefficients of M, N, and P, are smallest; but in a mountainous country, I conceive that an error of less than 4″ in the difference of latitudes is by no means inadmissible. And I am the more inclined to allow this error, because, upon applying the formula to the arc measured in Sweden by the French Academicians, the error, which is much greater than this, has a different sign.

I may here perhaps without impropriety, make some remarks on the credit which appears to be due to the French measure in Sweden. That measure has often been mentioned with contempt; but more particularly since the late measure by SVANBERG. I have not however been able to discover any reason for this contempt, except the disagreement of its results from those of other operations. The last part of the process, it is well known, was the measure of the base; and the Academicians themselves were so much astonished at the result, that they immediately proceeded to verify every part of the measure, particularly the latitudes. And the general accuracy of the measure has been confirmed by the late measure. The triangles were admirably chosen; the length of the arc agrees within a few fathoms with that found by SVANBERG; the latitude of the southern extremity at Tornea is precisely the same as that calculated by SVANBERG from the observations at Mallorn; the latitude of Kittis,

their northern station, unfortunately was not examined. The presumption, I think is, that though a part of the discrepancy may be attributed to errors of observation, yet a great part of it must be due to the irregularities of local attraction in so rugged a country (though SVANBERG appears to think this impossible), and that the new measure probably is not free from errors of the same kind. The measure at the Cape of Good Hope, conducted by the ablest astronomer of the age, has generally been thought inadmissible for the same reason.

Since $L' - L = \sin 1'' \times$ number of seconds in $L' - L$, we have for the length of a meridian arc $\frac{16,88164}{\sin 1''} \left\{ L' - L - \frac{9358 \times \sin 1''}{16,88164} \times (\sin 2L' - \sin 2L) + \frac{267 \times \sin 1''}{16,88164} (\sin 4L' - \sin 4L) \right\}$. Comparing this with the formula in (20), $\frac{3e}{4} - \frac{3e^2}{8} = \frac{9358 \times \sin 1''}{16,88164}$, and $\frac{15e^2}{64} - \frac{15A}{32} = \frac{267 \times \sin 1''}{16,88164}$. From these equations $e = ,003589 = \frac{1}{278,6}$; $A = -,000157$. The difference between the polar and equatorial axes is even greater than that assigned by Captain SABINE. But the most striking difference in the deductions is that the value of A, now found, has a negative sign; which would seem to indicate that the earth is protuberant at the latitude 45° above the ellipsoid, which has the same axes. And it does not appear that by any alteration of the values of A and e it is possible to reconcile the different observations. If we suppose the Indian and French arcs to be quite accurate, we shall find $e = ,003269 - A \times 2,139$: this evidently cannot be reconciled with the values of e and A deduced from the pendulum experiments.

On the whole I conceive, that we cannot assert that, on the

figure of the earth, theory and observation are in perfect agreement. If the arcs which have been measured were no longer than that in Sweden, or even than that in England, I should not hesitate in attributing to errors of observation and local attraction a considerable part of the discrepancy. And had the theory been confined to terms of the first order, I should have thought it probable that terms of importance might be omitted in the second and higher orders. But it appears that with the improved theory, applied to the comparison of the Indian and French arcs, the shorter of which has an amplitude of nearly ten degrees, it is impossible to establish any agreement with the pendulum observations of Captain SABINE; and I know no other series which for extent and other advantages can be compared with those.

The measures of arcs of the meridian which have hitherto been made are, I imagine, insufficient for the determination of the figure of the earth. The arcs in India and France are the only ones in which the possible errors in latitude would not bear a sensible proportion to the effects of ellipticity. Captain SABINE has proposed to measure an arc in Spitzbergen. The shortness of the arc, and the mountainous character of the country, would make it almost useless. The desideratum at present is an extensive arc in a high latitude. We have two good arcs near the equator; of which the Indian, at least, is as long as can be desired. We have a still longer arc almost exactly bisected by the parallel of 45°. With an arc of equal length in the neighbourhood of the pole, we might determine the three terms in the expression for an arc of the meridian to great accuracy. This perhaps it will be impossible ever to execute.

There are some measures in which such extraordinary disturbances appear to have existed, that it seems desirable to examine and extend them: of these, the most remarkable is that made by LACAILLE at the Cape of Good Hope. And perhaps in speaking of the probable effects of local attraction, I may be permitted to allude to one of a different kind in England. This is the correction which it has been found necessary to apply to the longitudes of places in England, as deduced from the observations made at Beachy Head and Dunnose. For this investigation I prefer the method of DALBY, explained in the Philosophical Transactions for 1790 and 1795, to any other; as being unobjectionable on the ground of accuracy, and as applying to any surface in which the intersections of the normals at the two stations with the earth's axis, or with a line parallel to the earth's axis, are not very distant. The difference of longitude is then made to depend on this case of spherical trigonometry: given two sides (a, b) and the sum of the opposite angles ($A + B$), to find the third angle (c). The formula is, $\tan. \frac{c}{2} = \frac{\cos. \frac{a-b}{2}}{\cos. \frac{a+b}{2}} \cot. \frac{A+B}{2}$.

In this instance $a =$ colatitude of Dunnose $= 39° 22' 52'',69$; $b =$ colatitude of Beachy Head $= 39° 15' 36'',29$; $A + B =$ sum of observed azimuths $= 178° 52' 51''$; hence $C = 1° 26' 47'',87$. And if the errors in the observed quantities a, b, A, B, were δa, δb, δA, δB, the error in C would be

$$-\frac{\cos. \frac{a-b}{2} . \cos.^2 \frac{C}{2}}{\cos. \frac{a+b}{2} . \sin.^2 \frac{A+B}{2}} (\delta A + \delta B) + \frac{\cos. \frac{A+B}{2} . \cos.^2 \frac{C}{2}}{\cos.^2 \frac{a+b}{2}} (\sin. b. \delta a + \sin. a. \delta b) = -1,293 (\delta A + \delta B) + ,0103 . \delta a + ,0104 . \delta b.$$

Now the chronometer observations for the difference of

longitude of Dover and Falmouth, according to Dr. TIARKS, (Phil. Trans. 1824) give by proportion the difference of longitude of Dunnose and Beachy Head $1^{\circ}\ 27'\ 4'',75$. The discrepance then is nearly $17''$; which (since a small error in a or b produces an almost insensible effect on C) implies an error of $13''$ in the sum of the azimuths. This I should think is absolutely impossible. We must suppose then either that, in consequence of some local attraction, the apparent difference of longitudes was altered, or that some error has crept into the observations of Dr. TIARKS. The method of obtaining apparent time by corresponding altitudes, which was employed by Dr. TIARKS, is not the most accurate, nor perhaps the most proper, when the whole time in dispute is only five seconds. As Dr. TIARKS has not given the details of the observations, it is impossible to form any correct estimation of their accuracy. If however any local attraction have drawn aside the plummet at the eastern station towards the east, and that at the western station towards the west, the longitude would thus be made to appear smaller than it really is. The error produced in the longitude of either place would be $= \frac{\text{deviation}}{\text{cos. lat.}}$: and thus an error in longitude of $17''$ would be accounted for by supposing the plummet at Beachy Head drawn $5'',4$ to the east, and that at Dunnose $5'',4$ to the west. Each of these is a larger deviation than we have reason to believe has taken place at any station in England; and it appears therefore desirable that the observations should be re-examined. This operation would not be difficult: the easiest method perhaps would be by rocket signals; and it is obvious, that the local causes which affected the difference of longitude found by observations of azimuth,

would produce exactly the same effect by disturbing the levels of the transit or other instruments used to obtain the time. The immediate effect of such observations then, would be merely to confirm or to refute the conclusions deduced from the observations of azimuth: if the observations of Dr. TIARKS should be considered free from objection, they would serve to establish, or to destroy the belief, that local attraction may produce sensible disturbances in longitude.

G. B. AIRY.

Since the above was written, I have been favoured by Captain SABINE with a more detailed statement than I had before seen of the extent and probable circumstances of an arc in Spitzbergen. It appears that an arc might be measured extending nearly from latitude 76° 25′ to 80° 35′: the extremities of which would be on islands at a small distance from the main land of Spitzbergen. With the same formula as before, the error to be used in the method of least squares would be

$$-\text{measured length} + M \times 15000 - N \times ,1338 + P \times ,201.$$

Upon comparing this expression with those given before, it will be observed, that this is the only error in which the coefficient of N has a large negative value; and that from the preponderance at present of negative signs in the coefficients of P, an error with a positive coefficient of P would be very desirable. On these accounts then, an arc of that extent in that latitude would contribute much to our knowledge of the figure of the earth. But it is very likely that there would be sensible disturbances in the latitudes of the extreme

stations. We cannot imagine a situation in which there is a greater probability that the difference of latitudes would be made too large, than when the latitudes are observed at two stations at the level of the sea, with high land between them. But this would depend much on the nature of the rocks. In Peru, for instance, though far more mountainous, it is probable that the disturbance was not great. If then, as Captain SABINE proposes, any preliminary survey be made, it would perhaps be proper to examine not only the circumstances which would affect the practical facility of the operation, but also those which might have an influence on the determination of the latitudes; and should these be found not very unfavourable, a meridian arc of four degrees measured with great care would be highly valuable.

ADDITIONS.

THE equations of Art. 15, it will easily be seen, are equally true, whether the interior of the mass be supposed to be fluid, or to consist of solid shells of different density, in which the radius of each separating surface is expressed by the formula $a\left\{1 + e.\sqrt{1-\mu'^2} - \left(\frac{3e^2}{2} + A\right)\sqrt{\mu'^2 - \mu'^4}\right\}$. And the expression for gravity in Art. 19, and all its consequences, hold equally on either supposition.

A theorem similar to CLAIRAUT'S may be shown to be true, to whatever order the investigations be extended. For upon using the value of R found in the investigation above, and upon carrying all the operations one step farther, it would be found that the equation of equilibrium could not

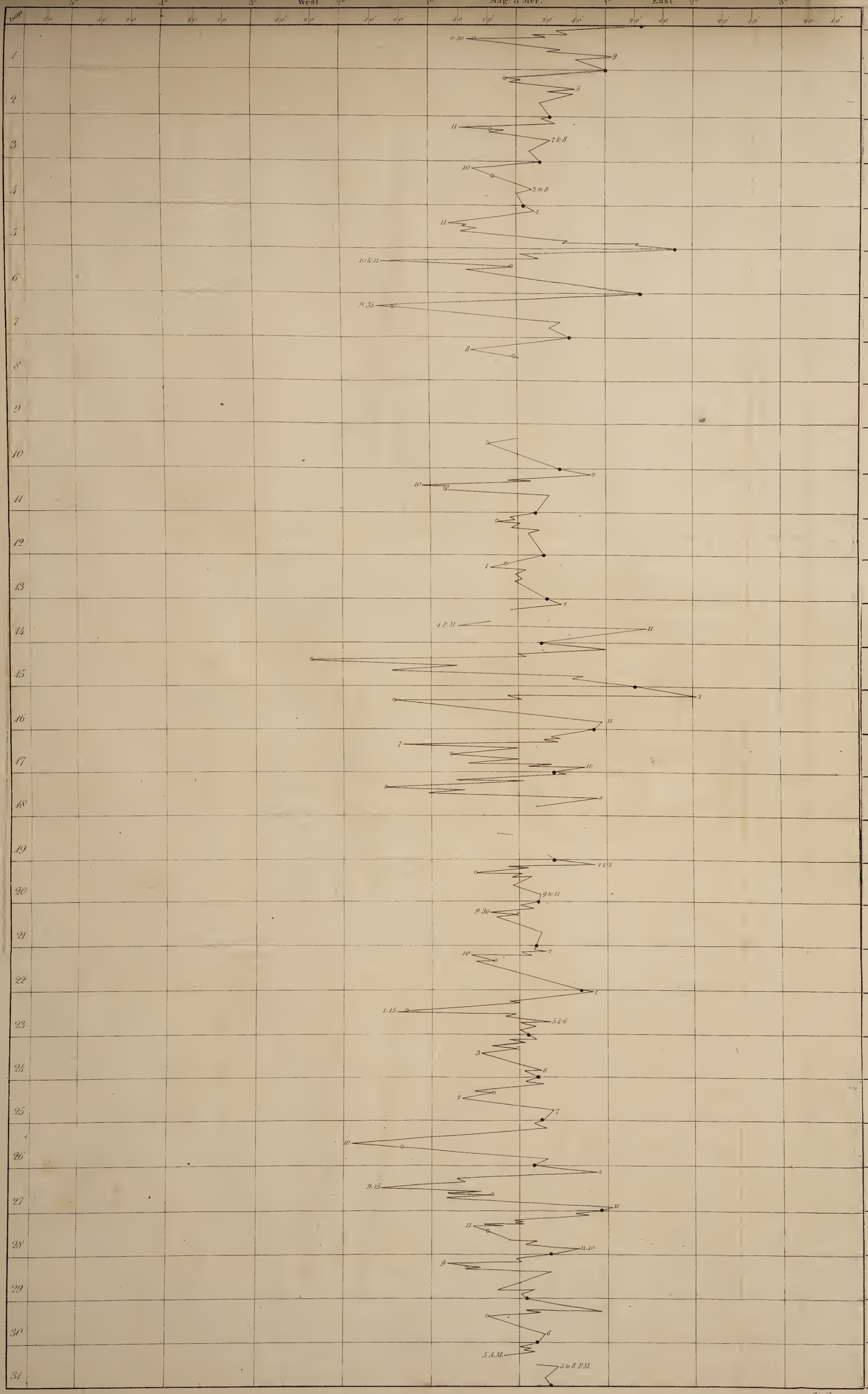
be satisfied, in consequence of the introduction of terms multiplying μ'^6, which would not destroy each other. It would be necessary then to assume for R a value of the form

$$a\left\{1+e.\overline{1-\mu'^2}-\left(\frac{3e^2}{2}+A\right).\overline{\mu'^2-\mu'^4}-\left(\frac{e^3}{2}+B\right).\overline{\mu'^2-6\mu'^4+5\mu'^6}\right\}:$$

by which there would be introduced two new functions of *a*, *e*, &c. in the general expression for V, and in that for the force at any point; and one new function of a, e, &c. in the expression for the force at the surface. But as a power of μ' is introduced, which did not appear before, there would be found, by the process of Art. 14, one equation which was not found in the preceding approximation. By this equation the new function could be eliminated, and therefore the force at any point could be expressed in the same manner as in the preceding approximation, namely, by means of one function of (a) multiplying a quantity depending solely on the form of the external surface, and the latitude of the point on that surface. The same may be proved for every succeeding approximation; and thus we arrive at the following theorem: "If a heterogeneous fluid, the particles of which attract each other with accelerating forces inversely proportional to the squares of their distances, revolve round an axis; and if the proportion of the centrifugal force at the equator to the whole force there be given; the force at any point of the surface can be exactly expressed from a knowledge of the form of the surface and the position of that point, without any knowledge of the law of the internal density." This is likewise true if the interior be solid.

G. B. A.

JANUARY.—1825.

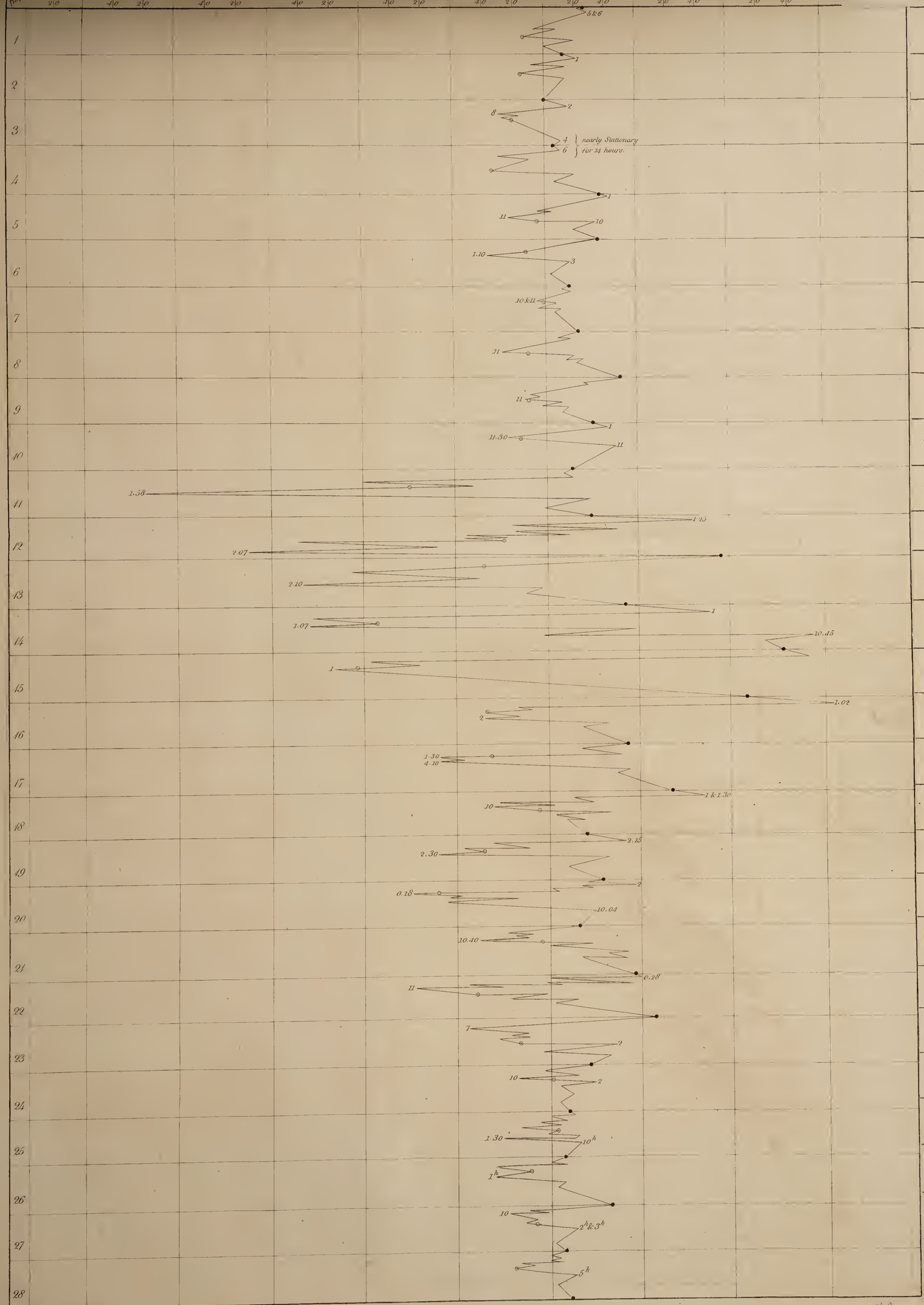


1825.	On the S. Meridian.	On the N. Meridian.	Time of passing.	Zenith Distance.	Time of passing.	Zenith Distance.
	° ′	° ′	h. m.	° ′	h. m.	° ′
1	96 14	129 43	9 20 P. M.	49 47	8 53 A. M.	83 46
2	96 09	129 38	10 17 P. M.	49 14	9 48 A. M.	82 55
3	96 03	129 32	11 16 P. M.	50 09	10 46 A. M.	83 02
4	95 57	129 25			11 44 A. M.	84 45
5	95 50	129 18	0 14 A. M.	52 42	0 43 P. M.	88 02
6	95 43	129 11	1 11 A. M.	56 39	1 39 P. M.	92 34
7	95 35	129 03	2 06 A. M.	61 46	2 33 P. M.	97 54
8	95 27	128 55	2 58 A. M.	67 26	3 23 P. M.	104 10
9						
10	95 09	128 36	4 39 A. M.	79 37	5 04 P. M.	116 00
11	95 00	128 27	5 30 A. M.	85 09	5 55 P. M.	121 11
12	94 51	128 18	6 21 A. M.	89 52	6 47 P. M.	125 26
13	94 41	128 08	7 13 A. M.	93 40	7 40 P. M.	128 34
14	94 31	127 57	8 04 A. M.	96 08	8 31 P. M.	130 24
15	94 20	127 46	8 58 A. M.	97 10	9 25 P. M.	130 43
16	94 08	127 34	9 52 A. M.	96 53	10 19 P. M.	129 44
17	93 56	127 22	10 45 A. M.	95 20	11 10 P. M.	127 35
18	93 44	127 10	11 35 A. M.	92 36		
19	93 31	126 57	0 25 P. M.	88 55	00 02 A. M.	124 24
20	93 18	126 44	1 09 P. M.	84 43	0 47 A. M.	120 26
21	93 05	126 31	1 51 P. M.	80 07	1 30 A. M.	115 58
22	92 51	126 17	2 31 P. M.	75 18	2 11 A. M.	111 05
23	92 37	126 02	3 11 P. M.	70 14	2 51 A. M.	106 12
24	92 23	125 47	3 52 P. M.	65 23	3 31 A. M.	101 20
25	92 08	125 32	4 34 P. M.	60 53	4 13 A. M.	96 39
26	91 53	125 17	5 19 P. M.	56 48	4 56 A. M.	92 17
27	91 37	125 01	6 06 P. M.	53 20	5 41 A. M.	88 30
28	91 21	124 45	6 58 P. M.	50 47	6 32 A. M.	85 29
29	91 05	124 29	7 54 P. M.	49 32	7 25 A. M.	83 28
30	90 49	124 13	8 52 P. M.	49 32	8 23 A. M.	82 48
31	90 32	123 56	9 50 P. M.	51 09	9 21 A. M.	83 41

F.e Basire, sc.

Note. *The dark circular spots indicate Midnight; the light ones, Noon; and the intervening figures, the intermediate hours.*

FEBRUARY._1825.

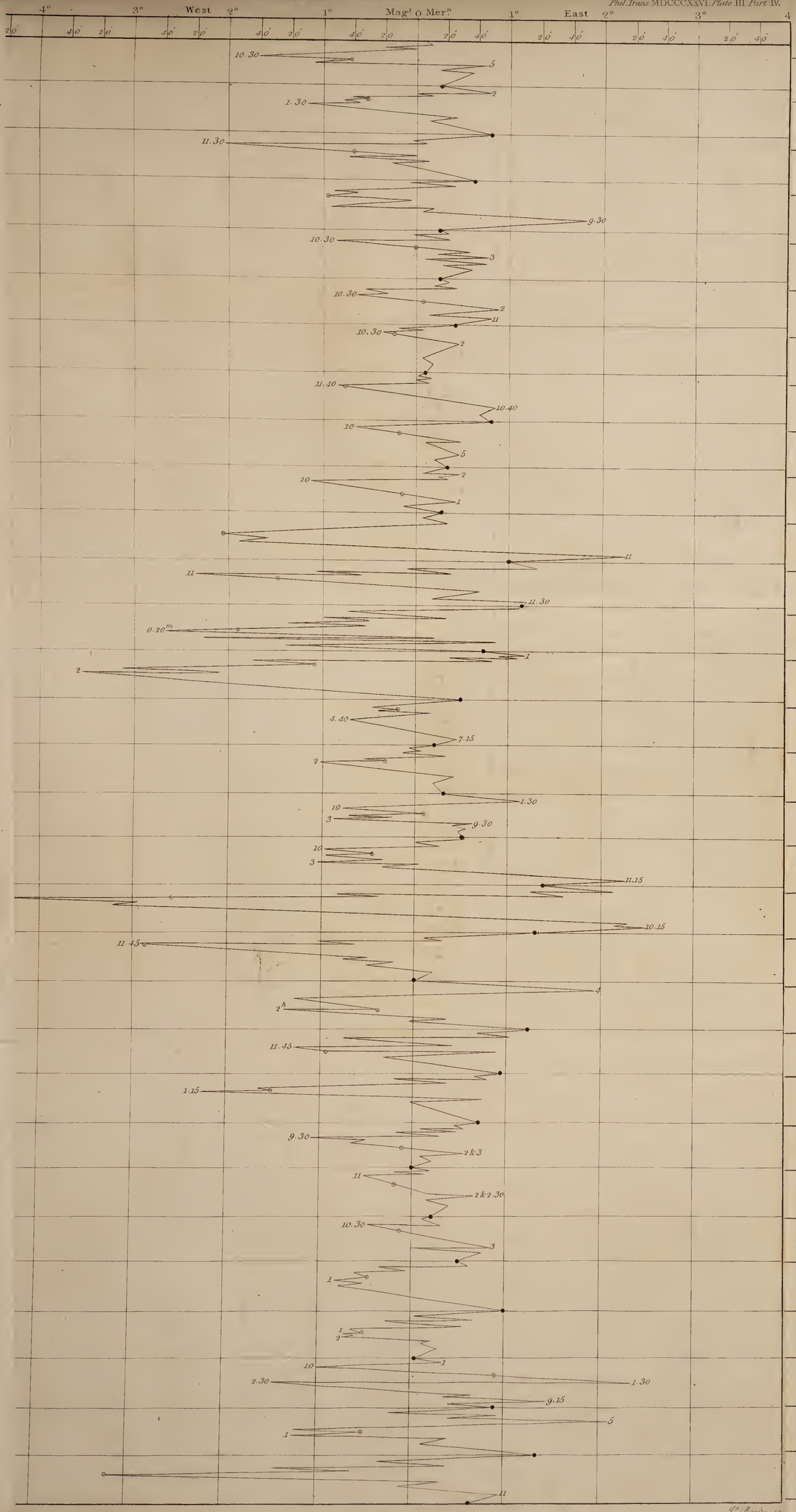


	° ′	° ′	h. m.	° ′	h. m.	° ′
1	90 15	123 38	10 45 P. M.	54 43	10 18 A. M.	86 06
2	89 58	123 21	11 43 P. M.	59 01	11 14 A. M.	90 06
3	89 40	123 04			0 11 P. M.	95 13
4	89 22	122 45	0 38 A. M.	64 39	1 05 P. M.	101 13
5	89 04	122 27	1 32 A. M.	70 48	1 59 P. M.	107 31
6	88 46	122 08	2 25 A. M.	77 08	2 51 P. M.	113 40
7	88 27	121 49	3 17 A. M.	83 04	3 43 P. M.	119 04
8	88 08	121 30	4 10 A. M.	88 13	4 37 P. M.	124 00
9	87 49	121 11	5 05 A. M.	92 24	5 32 P. M.	127 34
10	87 30	120 52	6 00 A. M.	95 21	6 27 P. M.	129 50
11	87 10	120 32	6 54 A. M.	96 53	7 21 P. M.	130 39
12	86 49	120 12	7 48 A. M.	97 01	8 14 P. M.	130 06
13	86 29	119 52	8 41 A. M.	95 49	9 06 P. M.	128 20
14	86 09	119 31	9 31 A. M.	93 30	9 55 P. M.	125 31
15	85 48	119 10	10 19 A. M.	90 13	10 42 P. M.	121 50
16	85 27	118 49	11 04 A. M.	86 15	11 26 P. M.	117 35
17	85 06	118 28	11 46 A. M.	81 48		
18	84 45	118 07	0 28 P. M.	76 58	0 06 A. M.	112 56
19	84 24	117 46	1 08 P. M.	72 05	0 48 A. M.	107 44
20	84 03	117 25	1 49 P. M.	67 24	1 28 A. M.	103 10
21	83 41	117 03	2 30 P. M.	62 36	2 09 A. M.	98 48
22	83 19	116 41	3 13 P. M.	58 19	2 51 A. M.	93 53
23	82 57	116 19	3 58 P. M.	54 44	3 36 A. M.	90 01
24	82 35	115 57	4 48 P. M.	51 53	4 22 A. M.	86 45
25	82 13	115 35	5 40 P. M.	50 04	5 13 A. M.	84 24
26	81 51	115 12	6 34 P. M.	49 29	6 07 A. M.	83 08
27	81 28	114 49	7 31 P. M.	50 21	7 02 A. M.	83 16
28	81 05	114 26	8 28 P. M.	52 41	8 00 A. M.	84 52

Note, *The dark circular spots, indicate Midnight; the light ones, Noon; and the intervening figures, the intermediate hours.*

MARCH.—1825.

Phil. Trans. MDCCCXXVI. *Plate* III. *Part* IV.



Note, *The dark circular spots, indicate Midnight; the light ones Noon; and the intervening figures, the intermediate hours.*

J.s Basire, sc

March 1825.	Sun's Zenith Distance. On the S. Meridian.	Sun's Zenith Distance. On the N. Meridian.	Moon on the South Meridian. Time of passing.	Moon on the South Meridian. Zenith distance.	Moon on the North Meridian. Time of passing.	Moon on the North Meridian. Zenith distance.
	° ′	° ′	h. m.	° ′	h. m.	° ′
1	80 42	114 03	9 26 P. M.	56 31	8 58 A. M.	87 56
2	80 19	113 40	10 22 P. M.	61 31	9 54 A. M.	92 25
3	79 56	113 17	11 18 P. M.	67 22	10 50 A. M.	97 53
4	79 33	112 54			11 44 A. M.	104 03
5	79 10	112 31	00 12 A. M.	73 41	0 39 P. M.	110 27
6	78 47	112 08	1 07 A. M.	80 01	1 34 P. M.	116 34
7	78 24	111 45	2 02 A. M.	85 52	2 29 P. M.	121 57
8	78 01	111 22	2 57 A. M.	90 33	3 26 P. M.	126 02
9	77 38	110 58	3 54 A. M.	94 08	4 23 P. M.	128 53
10	77 15	110 35	4 51 A. M.	96 14	5 20 P. M.	130 16
11	76 51	110 11	5 48 A. M.	96 52	6 14 P. M.	130 12
12	76 27	109 47	6 41 A. M.	96 06	7 07 P. M.	128 47
13	76 03	109 23	7 34 A. M.	94 10	7 56 P. M.	126 17
14	75 40	109 00	8 22 A. M.	91 10	8 42 P. M.	122 55
15	75 16	108 36	9 08 A. M.	87 27	9 26 P. M.	118 54
16	74 53	108 13	9 51 A. M.	83 09	10 08 P. M.	114 25
17	74 29	107 49	10 33 A. M.	78 30	10 49 P. M.	109 40
18	74 05	107 25	11 14 A. M.	73 42	11 30 P. M.	104 49
19	73 41	107 01	11 54 A. M.	68 50		
20	73 17	106 37	0 36 P. M.	64 13	0 12 A. M.	100 02
21	72 53	106 13	1 20 P. M.	59 51	0 55 A. M.	95 30
22	72 30	105 50	2 04 P. M.	56 03	1 39 A. M.	91 21
23	72 06	105 26	2 51 P. M.	52 56	2 26 A. M.	87 56
24	71 42	105 02	3 42 P. M.	50 48	3 16 A. M.	85 18
25	71 18	104 38	4 35 P. M.	49 49	4 08 A. M.	83 41
26	70 55	104 15	5 29 P. M.	50 07	5 02 A. M.	83 20
27	70 31	103 51	6 25 P. M.	51 48	5 57 A. M.	84 19
28	70 08	103 28	7 20 P. M.	54 52	6 52 A. M.	86 42
29	69 45	103 05	8 15 P. M.	59 13	7 47 A. M.	90 25
30	69 22	102 42	9 08 P. M.	64 26	8 41 A. M.	95 13
31	68 59	102 19	10 02 P. M.	70 25	9 35 A. M.	100 54

PRESENTS

RECEIVED BY THE

ROYAL SOCIETY,

From 17th November, 1825, to 15th June, 1826.

WITH THE

NAMES OF THE DONORS.

PRESENTS.	DONORS.
ACADEMIÆ et SOCIETATES.	
Magnæ Britanniæ.	
SOCIETY OF ANTIQUARIES. — Archaeologia; or, Miscellaneous Tracts relating to Antiquity. Published by the Society of Antiquaries of London. Vol. XXI. Part I. 4to 1826.	The Society of Antiquaries.
ROYAL INSTITUTION.—A Journal of Science, Literature, and the Arts. Nos. 38–41. 8° *Lond.*	The Managers of the Royal Institution.
SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES AND COMMERCE.—Transactions of the Society instituted at London for the Encouragement of Arts, Manufactures, and Commerce, with the Premiums offered in the year 1824. Vol. XLIII. 8° *London*, 1825.	The Society for the Encouragement of Arts, Manufactures, and Commerce.
HORTICULTURAL SOCIETY.—Transactions of the Horticultural Society of London. Vol. VI. Part III. 4°.	The Horticultural Society.
——————————— Report of the Garden Committee. March 31, 1826.	
ASTRONOMICAL SOCIETY.—Memoirs of the Astronomical Society of London. Vol. II. Part I. 4°.	The Astronomical Society.
ROYAL ASIATIC SOCIETY.—Transactions of the Royal Asiatic Society of Great Britain and Ireland. Vol. I. Part II. 4° *London.*	The Royal Asiatic Society.
ROYAL IRISH ACADEMY.—Transactions of the Royal Irish Academy. Vols. XI. XII. and XIV. 4° *Dublin.*	The Royal Irish Academy.
MEDICAL and CHIRURGICAL SOCIETY.—Medico-Chirurgical Transactions. Vol. XIII. Part. I. 8° *Lond.*	The Medical and Chirurgical Society.

PRESENTS.	DONORS.
ACADEMIÆ et SOCIETATES.	
AMERICAN PHILOSOPHICAL SOCIETY.—Transactions of the American Philosophical Society. Vol. II. New Series. 4°.	The American Philosophical Society.
Galliæ.	
SOCIÉTÉ DE GÉOGRAPHIE.—Recueil de Voyages et de Mémoires publié par la Société de Géographie. Tome 1ere. *Paris.* 4°.	The Geographical Society of Paris.
SOCIÉTÉ D'AMÉLIORATION DES LAINES.—Premier Bulletin. 8° *Paris.* 1825.	The Society.
Italiæ.	
ACADÉMIE DES SCIENCES DE TURIN.—Memorie della Reale Accademia delle Scienze di Torino. Tomo 29. 4° *Torino.*	The Royal Academy of Sciences of Turin.
Germaniæ.	
ACADEMIA LEOPOLDINO-CÆSAREA.—Nova Acta Physico-Medica Academiæ Cæsareæ Leopoldino-Carolinæ Naturæ Curiosorum. Tom. X. Part II. 4° *Bonnæ.*	The Cæsarean Academy of Naturalists at Bonne.
AIRY (G. B.) Mathematical Tracts on Physical Astronomy, the Figure of the Earth, &c. 8° *Cambridge.*	G. B. Airy, Esq.
ALMANAC. The Nautical Almanac and Astronomical Ephemeris for the year 1828. 8° *London.*	The Commissioners of Longitude.
———— White's Ephemeris, and the Imperial Almanac for 1826. 8° *London.*	The Worshipful Company of Stationers.
AMPÈRE (*M.*) Mémoire sur une Nouvelle Expérience Electro-Dynamique, sur son application à la formule que répresente l'action mutuelle de deux élémens de deux conducteurs Voltaiques, et sur de nouvelles conséquences déduites de cette formule ; suivi d'une Lettre à M. Gherardi rélative à l'éxplication de quelques Phénomènes Electro-Dynamiques. 8° *Paris,* 1825.	M. Ampère.
ANNALES DES MINES, Ou Recueil de Mémoires sur l'exploitation des Mines, et sur les Sciences qui s'y rapportent ; rédigées par le Conseil Général des Mines. Publiées sous l'Autorisation du Conseiller d'État, Directeur Général des Ponts et Chaussées et des Mines. Tome VII. Part IV. Tome VIII. Tome IX. et Tome X. Part I. et II. 8° *Paris.*	Le Conseil des Mines.
ANNALS OF PHILOSOPHY. New Series. From No. 55 to No. 66. 8° *London.*	J. G. Children and Richard Phillips, Esqrs.
ANNESLEY (JAMES) Sketches of the most prevalent Diseases of India. 8° *London.*	James Annesley, Esq.
AUTRAN (*M.*) École Spéciale de Commerce et d'Industrie à Marseille. Procès verbal de la distribution solennelle des Prix de la fin de l'année 1825. 8° *Marseille.* 1825.	M. Autran.

PRESENTS.	DONORS.
AVOGADRO (*Chev.*) 1er et 2me Mémoire sur la Densité des Corps solides et liquides comparée avec la grosseur de leurs Molécules, et avec leurs nombres affinitaires. 4° (Mem. della Reale Accad. delle Scienze di Torino. Tom. 30, 31.)	Chev. Avogadro.
BABBAGE (C.) A Comparative View of the various Institutions for the Assurance of Lives. 8° *Lond.* 1826.	Charles Babbage, Esq.
BAILLIE (M.) Lectures and Observations on Medicine. By the late Matthew Baillie, M. D. 8° *London.*	Mrs. Baillie.
BOSTOCK (J.) M. D. An Elementary System of Physiology. Vol. II. 8° *London.* 1826.	Dr. John Bostock.
BREMNER (JAMES) The Mystery of Magnetism fully discovered. By the Rev. James Bremner. 8° *London.*	The Revd. J. Bremner.
CHESS. Triple Chess, invented by Ph. Marinelli. Translated from the Italian. 8° *London,* 1826.	Mr. J. P. Yosy.
CLARKE (G.) Essay on the Cause of the Magnetism of the Needle. 8° *Southwark,* 1825.	George Clarke, Esq.
DAUBENY (C.) M. D. Sketch of the Geology of Sicily. (Corrected from the Edin. Phil. Journal.) 8°. 1825.	Dr. Charles Daubeny.
DESGRANGES (*M.*) Avis sur l'Administration des secours aux Personnes Noyées. Indication des secours qu'on doit administrer aux Personnes Noyées pour les rappeler à la vie. 4° *Lyon.*	Dr. Desgranges.
——— Observations et Remarques Pratiques sur l'Administration du Seigle Ergoté contre l'Inertie de la Matrice, dans la Parturition. 8° *Montpellier,* 1822.	———
DUBLIN PHILOSOPHICAL JOURNAL AND SCIENTIFIC REVIEW. Nos. 1–3. 8°.	The Editor.
DUNCAN (A.) M. D. The Edinburgh New Dispensatory. 11th edit. 8° *Edinb* 1826.	Dr. Duncan, Jun.
FERRARA (A. F.) De l'Influence de l'Air, au Sommet de l'Etna, sur l'Economie Animale. 8°. (Extrait du Journal Universel des Sciences Médicales, XXIV. p. 129.)	Prof. Ferrara.
——— Memoria sopra i Tremuoti della Sicilia in Marzo, 1823. 8° *Palermo.*	———
FLORA BATAVA. No. 68, 69, 70. 4° *Amst.*	H. M. The King of the Netherlands.
FLOURENS (P.) Récherches Expérimentales sur les Propriétés et les Fonctions du Système Nerveux dans les Animaux Vertébrés.	M. Flourens.
——— Expériences sur le Système Nerveux. 8° *Paris,* 1825	———
FOEDERA, Conventiones, Litteræ, et cujuscunque generis Acta Publica inter Reges Angliæ et alios quosvis Imperatores, Reges, Pontifices, Principes, vel Communitates, ab ingressu Gulielmi I. in Angliam, A. D. 1066, ad nostra usque tempora habita aut tractata. Vol. III. Pars I. (ab anno 1344, ad annum 1361,) folio, *Londini,* 1825.	The Commissioners of Public Records.
FRESNEL (M. A.) Mémoire sur la Diffraction de la Lumière.	M. Fresnel.
FROST (J.) An Oration delivered before the Medico-Botanical Society of London, Oct. 14, 1825. 4°.	John Frost, Esq.

PRESENTS.	DONORS.
GALLINI (s.) Summa Observationum Anatomicarum ac Physico-Chymicarum quæ usque ab anno 1792 expositæ præcurrerunt Nova Elementa Physicæ Corporis Humani. 8° *Patavii*, 1824.	Prof. Gallini.
——— Nuovi Elementi della Fisica del Corpo Umano, de dotti dalle più recenti osservazioni sull' Anatomia e sui fenomeni vitali dell' uomo e degli animali. Ed. seconda. 2 tom. 8° *Padova*, 1820.	———
GARNIER et QUETELET. Correspondance Mathématique et Physique. N. I—IV. 8° *à Gand*, 1825.	M. M. Garnier de Quetelet.
GAZOLA (G. B.) Lettera sopra la Descrizione d'un Pesce petrificato. 8° *Verona*, 1805.	Sig. G. B. Gazola.
GEORGET. Considerations Medico-Légales sur la Liberté Morale.	Dr. Georget.
GILBERT (D.) Mount Calvary; or the History of the Passion, Death, and Resurrection of our Lord and Saviour Jesus Christ. Written in Cornish (as it may be conjectured) some centuries past. Interpreted into the English Tongue in the year 1682, by John Keigwin, Gent. Edited by Davies Gilbert, F. R. S. F. S. A. &c. 8° *Lond.* 1826.	Davies Gilbert, Esq.
GRÄBERG (J.) Annali di Geografia, e di Statistica composti e pubblicati da Giacomo Gräberg. 2. tom. 8° *Genova*, 1802.	M. Gräberg de Hemsö.
——— Lezioni Elementari di Cosmografia, di Geografia e di Statistica. 8° *Genova*, 1819.	———
——— Lettera del Signor Gräberg di Hemsö sulla Peste di Tangieri negli anni 1818-19. 8° *Gen. e Tangieri*, 1820.	———
——— La Scandinavie Vengée, de l'accusation d'avoir produit les Peuples Barbares qui détruisirent l'Empire de Rome. 8° *Lyon*, 1822.	———
——— Théorie de la Statistique. 8° *Gênes*, 1824.	———
GRIFFIN (J.) Chemical Recreations; a series of Experiments, first lines of Chemistry, &c. By John Griffin. 12°. *Glasgow*, 1825.	Mr. John Griffin.
GUILDING (L.) An Account of the Botanic Garden in the Island of St. Vincent, from its first establishment to the present time. By the Rev. Lansdown Guilding, B. A. *plates*. 4° *Glasgow*, 1825.	The Rev. L. Guilding.
HALMA (*M. l'Abbé*) ΚΛΑΥΔΙΟΥ ΠΤΟΛΕΜΑΙΟΥ ΜΑΘΗΜΑΤΙΚΗ ΣΥΝΤΑΞΙΣ. Composition Mathématique de Claude Ptolemée, ou Astronomie Ancienne. Traduite pour la première fois du Grec en Français sur les Manuscrits de la Bibliothèque du Roi. Par M. l'Abbé Halma. Tome I. 4° *à Paris*, 1816.	M. L'Abbé Halma.
HAMILTON (W.) Prodromus Plantarum Indiæ Occidentalis. Digessit Gulielmus Hamilton, M. B. 8° *Lond.* 1825.	W. Hamilton, Esq.
HARLAN (R.) M D. Observations on the Genus Salamandra; and description of a new Genus of Quadrupeds of the order Edentata. (From the Annals of the New York Lyceum of Nat. Hist. Vol. I). 8°.	Dr. Richard Harlan

PRESENTS.	DONORS.
HASLER (F. R.) Papers on various subjects connected with the Survey of the Coast of the United States.	F. R. Hasler, Esq.
HAUGHTON (G. C.) Mánava-Dherma-Sástra; or the Institutes of Menu. Edited, and translated into English, by Graves Chamney Haughton, M. A. F.R.S. 2 vols. 4° *Lond.*	G. C. Haughton, Esq.
HEBERDEN (W.) M. D. The Letters of M. T. Cicero to T.P. Atticus. Translated into English, with Notes, by William Heberden, M. D. F. R. S. 2 vols. 8° *London.*	Dr. Heberden.
HILLARY (*Sir* W.) An Appeal to the British Nation on the humanity and policy of forming a National Institution for the preservation of Lives and Property from Shipwreck. 4th edition. 8° *London*, 1825.	Sir W. Hillary, Bart.
HOLMAN (J.) Narrative of a Journey through France, Italy, &c. 8° *Lond.*	James Holman, Esq.
HOSACK (D.) M. D. An Inaugural Discourse delivered before the New York Horticultural Society, Aug. 31, 1824.	Dr. D. Hosack.
JOHNSON (J. R.) M. D. A Treatise on the Medicinal Leech. 8° *Lond.*	Dr. J. R. Johnson.
——— Further Observations on the Medicinal Leech. 8° *Lond.*	———
KELLY (P.) LL. D. Supplement to the Universal Cambist, for 1825.	Dr. P. Kelly.
KING (P. P.) Narrative of a Survey of the Intertropical and Western Coasts of Australia. By Captain Phillip P. King, R. N. F. R. S. 2 vols. 8° *Lond.*	Captain King.
KIRBY (and SPENCE) An Introduction to Entomology, or Elements of the Natural History of Insects, with Plates. Vol. III. and IV. 8° *London*, 1826.	The Rev. Wm. Kirby.
LAPLACE *(Marquis de)* Traité de Mécanique Céleste. Tome cinquième. 4° *Paris.*	Marquis de Laplace.
LEGRIS. La Mécanique des Gens du Monde, ou les Moteurs rendus plus puissants, plus nombreux, plus économiques, plus utiles, et plus faciles à employer. 8° *Paris*, 1824.	M. Legris.
——— La Nouvelle Mécanique Militaire, ou l'Art de faire la Guerre avec peu de Troupes. 8° *Paris*, 1825.	———
——— La Nouvelle Mécanique Agricole, ou L'Art de rendre l'Agriculture une fois plus productive avec moins de travaux de la part des Hommes. 8° *Par.* 1825.	———
LEROUX (J. J.) Cours sur les Généralités de la Medicine Pratique. 2 tomes. 8°.	M. Leroux.
LUCCOCK (J.) An Essay on the Elements of Cyclometry. 8° *London.*	Mr. John Luccock.
LYALL (R.) M. D. The Medical Evidence relative to the Duration of Human Pregnancy, as given in the Gardner Peerage Cause, with Introductory Remarks and Notes. 8° *Lond.* 1826.	Dr. R. Lyall.
MACAIRE (*M.*) Expériences pour servir à l'Histoire de l'Acide Muriatique (Hydro-chlorique). Par M. M. Macaire et Auguste De La Rive. 4° *Genève*, 1824.	M M. Macaire, et De La Rive.
MAJENDIE (M. F.) Précis Elémentaire de Physiologie. 2 tomes. *Paris.*	Dr. Majendie.

PRESENTS.	DONORS.
MARSDEN (W.) Numismata Orientalia Illustrata.—The Oriental Coins, Ancient and Modern, of his Collection described and historically illustrated. By Wm. Marsden, F.R.S. &c. Part II. 4° *London.*	William Marsden, Esq.
MECKEL (J. F.) Ornithorhynchi Paradoxi Descriptio Anatomica. Tab. Æneis. fol. *Lipsiæ*, 1826.	Prof. Meckel.
MOREAU (C.) East India Company's Records, founded on Official Documents. *London*, 1825.	César Moreau, Esq.
——— British and Irish Products and Manufactures exported from Great Britain. *Lond.* 1826.	———
MORRISON (ROBERT) D.D. The Chinese Miscellany; consisting of original Extracts from Chinese Authors in the Native Character; with Translations and philological Remarks. 4° *London.*	Dr. Robert Morrison.
PAGANI (M. G.) Mémoire sur le Principe des Vitesses Virtuelles. 4°.	M. Pagani.
PANORAMIC MISCELLANY. Nos. 1 and 2. 8° 1826.	J. Thelwall, Esq.
PASLEY (C. W.) An Enquiry into the System of General or Commissariat Contracts for supplying His Majesty's Forces in Great Britain with Bread and Meat, as compared with that of Regimental Purchases. 8° *Lond.*	Lieut. Col. C. W. Pasley.
PHILLIPS (*Sir* R.) Golden Rules of Social Philosophy; or A new System of Practical Ethics. 8° *Lond.* 1826.	Sir Richard Phillips.
PHILOSOPHICAL MAGAZINE AND JOURNAL. From No. 326 to No. 337. 8° *Lond.*	Richard Taylor, Esq.
PICTET (A.) An engraved Portrait of A. Pictet.	His Family.
PITMA (R. B.) A succinct View and Analysis of authentic information, extant in original works, on the practicability of joining the Atlantic and Pacific Oceans by a Ship Canal across the Isthmus of America. By Robert Birks Pitman. 8° *London*, 1825.	Mr. R. B. Pitman.
POINTE (J. P.) M. D. Éloge de Jean Janin de Combe-Blanche. 8° *Lyon*, 1825.	Dr. J. D. Pointe.
POISSON (*M.*) Second Mémoire sur la Théorie du Magnétisme. 4°.	M. Poisson.
PRICHARD (J. C.) An Analysis of the Egyptian Mythology. 8°.	Dr. J. C. Prichard.
DE PRONY (*M.*) Leçons de Mécanique Analytique. 2 tom. 4° *Paris*, 1815.	M. De Prony.
——— Note. Sur les avantages du nouvel Établissement d'un Professorat de Harpe, à l'École Royale de Musique et de Déclamation. 4° *Paris.*	
——— Notes sur les Intervalles Musicaux. 8°.	———
——— Nouvelle Méthode de Nivellement Trigonométrique. 4° *Paris*, 1822.	———
——— Description Hydrographique et Historique des Marais Pontins. 4° *Paris*, 1822.	———
——— Atlas des Marais Pontins. fol. *Paris*, 1823.	———
——— Recueil de cinq Tables. 1°. Pour faciliter et abréger les calculs des formules rélatives au mouvement des eaux dans les canaux découverts et les tuyaux de conduite. 2°, Pour présenter les résultats de cent soixante-sept expériences employées pour l'établissement de ces formules. 4° *Paris*, 1825.	———

PRESENTS.	DONORS.
PROUT (W.) M. D. Inquiry into the Nature and Treatment of Diabetes, Calculus, and other affections of the Urinary Organs. 2nd edit. 8° *Lond.* 1825.	Dr. W. Prout.
PUGH (S.) Observations sur le Calorique et sur la Lumière. 8° *Rouen.* 1826.	M. Pugh.
QUETELET (A.) Mémoire sur quelques constructions Graphiques des Orbites Planétaires. 4°.	M. Quetelet.
——— Mémoire sur une Nouvelle Manière de considerer les Caustiques, produites, soit par Réflexion soit par Réfraction. *vide* GARNIER.	———
DE LA RIVE (AUG.) Dissertation sur la partie de l'Optique qui traite des Courbes dites Caustiques. 4° *Genève.* 1823.	Prof. De La Rive.
——— Récherches sur le Mode de Distribution de l'Électricité Dynamique dans les Corps qui lui servent de Conducteurs. 4° *Genève.* 1825. (Extrait des Mémoires de la Société de Phys. et d'Hist. Nat. de Genève. T. III. 1^ere^ Part.)	———
——— Mémoire sur quelques-uns des Phénomènes qui presente l'Électricité Voltaique dans son Passage à travers les Conducteurs Liquides. 8°. (Annales de Chimie.) *vide* MACAIRE.	———
ROBERTS (W.) Meteorological Journal kept at George Town, Demarara, from February 1, 1821, to January 31, 1822.	Mr. W. Roberts.
ROBERTSON (A.) D. D. Astronomical Observations made at the Radcliffe Observatory at Oxford, from May 1, 1825, to May 1, 1826. By and under the direction of the Rev. Abram Robertson, D. D. F. R. S. Savillian Professor of Astronomy and Radcliffian Observer MS. fol,	The Trustees under the will of the late Dr. Radcliffe.
SABINE (*Capt.* E.) An Account of Experiments to determine the Figure of the Earth by means of the Pendulum vibrating seconds in different Latitudes. 4° *Lond.*	The Commissioners of Longitude.
SAGRA (R.) Discurso leido en la apertura publica de la Catedra de Botanica-Agricola por su Profesor D. Ramon de la Sagra. 4° *Habana.* 1825.	Prof. Ramon de la Sagra.
SALT (H.) An Essay on Dr. Young's and M. Champollion's Phonetic System of Hieroglyphics. 8° *London.*	Henry Salt, Esq.
SCARPA (A.) Lettera del Professore Cavaliere Antonio Scarpa sopra un Elmo di Ferro squisitamente lavorato a cesello. fol. *Pavia.* 1825.	Prof. Scarpa.
SCHUMACHER (H. C.) Astronomische Abhandlungen. Drittes Heft. *Altona.* 1825.	Prof. Schumacher.
——— Astromische Hülfstafeln für 1826. 8° *Copenhagen.*	———
——— Astronomische Nachrichten. N° 80—90. 4° *Altona.*	———
SCROPE (G. P.) Considerations on Volcanos; the probable causes of their phenomena, the laws which determine their march, the disposition of their products, and their connexion with the present State and past History of the Globe; leading to the establishment of a New Theory of the Earth. 8° *Lond.* 1825.	G. P. Scrope, Esq.

PRESENTS.	DONORS.
SCUDAMORE (C.) M. D. Observations on M. Laennec's Method of forming a Diagnosis of the Diseases of the Chest by means of the Stethoscope and of Percussion. 8° *Lond.* 1826.	Dr. Charles Scudamore.
SMITH (*Sir* JAMES EDWARD) The English Flora. Volume III. 8° *London.*	Sir James Edward Smith.
STOCKLER. Methodo Inverso dos Limites ou Desenvolvimento Geral das Funçdes Algorithmicas. 4° *Lisboa.* 1824.	D. Francisco de Borja G. Stockler.
STRUVE (F. G. W.) Observationes Astronomicæ Institutæ in Speculâ Universitatis Cæsareæ Dorpatensis. Vol. IV. (Obs. annorum 1822 et 1823.) 4° *Dorpati,* 1825.	Prof. Struve.
TANTINI (F.) Esperienze Mediche del Dottore Francesco Tantini. 8° *Pisa.* 1825.	Dr. F. Tantini.
TODD (H. J.) The History of the College of Bonhommes at Ashridge, in the County of Buckingham, founded in the year 1276, by Edmund Earl of Cornwall. Compiled from original Records and other authentic sources. To which is added, A Description of the present Mansion, erected on the site of the ancient College. fol. with plates. *Lond.* 1823.	The Trustees of the late Earl of Bridgewater.
TOOKE (T.) Considerations on the State of the Currency. 8° *Lond.* 1826.	Thomas Tooke, Esq.
TRAVERS (B.) An Enquiry into that disturbed State of the Vital Functions usually denominated Constitutional Irritation. 8° *Lond.* 1826.	Benjamin Travers, Esq.
TYTLER (R.) M. D. Illustrations of Ancient History and Geography. 8° *Lond.* 1825.	Dr. Robert Tytler.
VALOR ECCLESIASTICUS. Temp. Henr. VIII. auctoritate regia institutus. Vol. V. fol. 1825.	The Commissioners of Public Records.
VETUSTA MONUMENTA, Vol. V. Tewkesbury Abbey. folio.	The Society of Antiquaries.
WARNER (R.) The History of the Abbey of Glaston, and of the Town of Glastonbury. 4°. *Bath.* 1826.	The Rev. R. Warner.
WEDDELL (JAMES.) A Voyage towards the South Pole, performed in the years 1822-24. 8° *Lond.*	James Weddell, Esq.
WESTON (S.) Historic Notices of Towns in Greece and in other Countries that have struck Coins. 8° *Lond.* 1826.	The Rev. Stephen Weston.
WILLIAMS (H.) A Map of the Sierra Leone Estuary, with its principal Islands, Rivers, and Creeks.	Henry Williams, Esq. of Sierra Leone.
THE ZOOLOGICAL JOURNAL. Nos. 6, 7, and 8. 8° *London.*	Thomas Bell, John G. Children, James de Carle Sowerby, and G. B. Sowerby; Esqrs.

INDEX

TO THE

PHILOSOPHICAL TRANSACTIONS

FOR THE YEAR 1826.

N. B. Parts I. and IV. are paged separately. The pages here refer to Parts II. and III. only, unless where expressed to the contrary.

A

Acid. A new, produced during action of sulphuric acid and naphthaline, 140. See *Sulpho-naphthalic acid.*
—— *acetic*, crystallized by a pressure of 1100 atmospheres, 544.
—— *sulphuric*, its action on naphthaline, 140—on alcohol, 240—its perfect fixity at common temperatures, 489.
Adjustment of standard weights and measures by Capt. KATER, 11 *et seq.*
Air, atmospheric, its apparent liquefaction by pressure, 545.
AIRY, G. B. Esq. M. A. On the figure of the earth, 548.
Alloy of copper, tin and brass, proper for delicate works, 9.
Alloys, ancient, Dr. J. DAVY's account of changes in, 55.
Aneurism, case of, treated by coagulation of the blood by heat, 189.
Animal heat influenced by the nerves—proofs of this influence, 60.
Animals, marine, burrowing and boring, Mr. OSLER's account of their habits and structure, 342 *et seq.*
Annuities. Principles for computing their present values in some cases, 299.
Arcs of meridian employed by Mr. AIRY to deduce the figure of the earth, 567.
Arenicola Piscatorum, its mode of boring, 343.
Atmosphere. Mr. DALTON on its constitution, 174.

INDEX.

Atmospheric refraction at Port Bowen, Lieut. FOSTER's observations on, Part IV. No. 6.

Attraction, local, cases in which its influence appears to be sensible pointed out, 574.

Aurora Borealis, its effect on the magnetic needle imperceptible at Port Bowen, IV. 176.

B

BABBAGE, CHARLES, Esq. F. R. S., on a method of expressing by signs the action of machinery, 250.

——————————— on electric and magnetic rotations, 496.

Bakerian Lecture. On the relations of electrical and chemical changes, by Sir H. DAVY, Bart. P. R. S. 383.

Balance for weighing great weights accurately, Capt. KATER's account of the construction of one, 36.

BELL, C. Esq., on a nervous circle connecting the voluntary muscles with the brain, 163.

BEVAN, B. Esq., his account of experiments on the elasticity of ice, 304.

Bivalves, their mode of burrowing in sand, 348—locomotive, their mode of travelling, 350.

Blindness from birth, a case of, removed, in a lady of advanced age, 529.

Blood in aneurismal tumours, coagulation of by heat, 189—effect of heat on, out of the body, 196—buffy after venesection, a new fact respecting, 199.

BOHNENBERGER, Professor, his claim to the first invention of the convertible pendulum admitted, 52.

BONNE, Colonel, his observations of signals for determining the longitude of Paris, 86.

Boring and burrowing marine animals. Mr. OSLER on, 342.

Bowen, Port. See *Port Bowen.*

Bridges (suspension), their mathematical theory, 202.

BRINKLEY, Rev. J., on the application of Capt. KATER's floating collimator to the Dublin circle, 307.

C

Cambridge observatory, Mr. WOODHOUSE on its transit instrument, 75.

Camphor. A mode of obtaining it and other volatile solids in crystals, 490.

Carburetted hydrogen, its liquefaction by pressure, 546.

Catenary, common, Tables for its construction, and properties of it useful in theory of bridges, 203. 212.
Catenary of equal strength, theory of, 206—Tables for its construction, 206. 216.
CHRISTIE, S. H. Esq., on magnetic influence in the solar rays, 219.
———— his experiments on the magnetism of an iron plate repeated by Lieut. FOSTER at Port Bowen, IV. 188, No. 8.
———— his remarks on the above-mentioned repetition of his experiments, Part IV. 200.
Circle, nervous, connecting voluntary muscles with the brain. Mr. BELL on, 163.
CLAIRAUT'S *theorem* respecting the figure of the earth, extended by Mr. AIRY, 577.
Climacteric years according to different tables, 302, 303.
Clock, eight day, its mechanism expressed by Mr. BABBAGE'S notation, 262.
Coagulation of blood by heat in aneurism, 189.
Cold, sensible, Dr. HEBERDEN'S remarks on, 69.
Collimator, Capt. KATER'S, results of its application to the Dublin circle, 307—its importance, 308.
Compression of water, Mr. PERKINS'S experiments on, 541—Table of, up to 1000 atmospheres, 547.
Copper, ancient alloys of, Dr. DAVY'S account of changes in, 55.
Crystallization of metals on the surface of ancient coins, &c. 58.
———— of camphor, 490.

D

DALTON, J. Esq., on the constitution of the atmosphere, 174.
DAVY, Sir H. Bart. P. R. S., his Bakerian Lecture on relation between electrical and chemical changes, 383.
——- Dr. J., on changes in ancient alloys of copper, &c. 55.
———— on the poison of the common toad, 127.
DELARIVE, M., some voltaic phænomena observed by, explained, 413.
Deer, horns of, experiments on their heat, 60 *et seq.*
Dip of the magnetic needle at Woolwich and at stations within the Arctic circle, Part IV. No. 3, p. 126.
Double Stars (and Triple), Mr. SOUTH'S observations of 458 of them, and re-examination of 36 others, Part I.—N. B. The Catalogue at the end of this Part is arranged to serve as an Index to this and Part III. 1824.
———— Sir W. HERSCHEL'S observations of, compared with Mr. SOUTH'S and others, Part I. *passim.*

INDEX.

DRUMMOND, Lieut., on a means of facilitating the observations of distant stations in geodætical operations, 324.

E

Earth. G. B. AIRY, Esq. on the figure of, 548.
Earths, their power of emitting intense light when violently heated. 330.
Elasticity of ice. Mr. BEVAN's determination of, 304.
Electricities regarded as transporters of ponderable matter, 417.
Electric and magnetic rotations. Mr. BABBAGE on, 494.
Electrical and chemical changes. Sir H. DAVY on their relation, 383.
——— states of bodies, how ascertained, 390.
——— combinations of metals and fluids, 393 *et seq.*—compound ditto, 409.

F

Fairlight Down a station for geodætical observations, 77.
FARADAY, M. Esq. on the mutual action of sulphuric acid and naphthaline, and on a new acid produced, 140.
——— on the existence of a limit to vaporization, 484.
Fibre, muscular, its structure, Mr. BAUER's observations on, 65.
Figure of the Earth. Mr. AIRY on, 548.
FOSTER, Lieut. H., R.N. F.R.S., his account of experiments made with the invariable pendulum at Port Bowen, Part IV.
——— magnetic observations of the variation, dip and intensity at Port Bowen and elsewhere, ibid. p. 73, &c.
——— observations of diurnal changes in the position of the magnetic needle under reduced directive forces, Part IV. p. 129 *et seq.* (No. 2, 3,) 4, 5.
——— comparison of diurnal changes of intensity in the dipping and horizontal needle at Port Bowen, IV. p. 177, No. 7.
——— observations to determine the amount of atmospheric refraction at Port Bowen, IV. &c. No. 9.
——— account of the repetition of Mr. CHRISTIE's magnetic experiments, &c. at Port Bowen, IV. 188, No. 8.
Formula for computing the mean resulting difference of longitudes from a series of observations of signals, 113—for rates of chronometers therein used, 115.
——— for calculating the effect of annual parallax on the angle of position of a double star, 274.
——— for the decrement of human life by Dr. YOUNG, 281.
——— for the number of deaths among a given number of persons born in the same year, 288.

G

Gallon, imperial standard, defined, 8.
Galvanometer, Sir H. DAVY's description of one used by him, 391.
Gases, their distribution in the atmosphere at different heights, 185.
GAUSS, *Professor*, his principle of solar signals employed in the Irish Survey, 325.
Geodætical operations, Mr. DRUMMOND on a means of facilitating, 324—description of instruments used in by ditto, 327 *et seq.*
Geodætical stations between London and Paris, 77 *et seq.*
GILBERT, D. Esq. on the mathematical theory of suspension bridges, 202.
Grain, determination of the imperial standard, from the cubic inch of water, 8.
Greenwich, observations at, for determining the difference of meridians between it and Paris, 93.

H

Heat, animal, proofs of its being influenced by the nerves, 60.
—— radiation of through glass screens, Mr. POWELL's experiments on, 372.
—— of July 1825, amount of, 69 — of 1808, 70 — at Kingston in Jamaica, 71.
HEBERDEN, Dr. W., his account of the heat of July 1825, with remarks on sensible cold, 69.
Heliotrope of Professor GAUSS, its principle employed by Mr. DRUMMOND, 325—description of a, 327.
HENNELL, H. Esq. on the action of sulphuric acid on alcohol, 240.
HERSCHEL, J. F. W. Esq., his account of observations for ascertaining the difference of meridians between Greenwich and Paris, 77.
———————— on the parallax of the fixed stars, 266.
Historical details relative to electro-chemistry, 384.
HOME, Sir E. Bart., his additional proofs of animal heat being influenced by the nerves, 60.
——— his Croonian Lecture on the structure of a muscular fibre, from which are derived its elongation and contraction, 64.
——— on the coagulation by heat of blood in an aneurismal tumour, 189.
——— on the production and formation of pearls, 338.
Horns of deer. Experiments on their heat, 60.
Hydrocarbon, its union with sulphuric acid, 144. 160.
———————— with muriatic ditto, 160.

Hydrocarbon, with sulphuric acid in oil of wine, 242—analysis of, 247.
Hydrogen, its combination with chlorine effected by the light of incandescent lime, 333.
Hydrosulphurets exert a powerful electrical action on copper, 395.
Hygrometer, an improved, by Mr. JONES, described, 53.

I

Ice, elasticity of, determined, 304.
Incrustations on ancient alloys, coins, &c. 57.
Intensity of magnetism at Port Bowen, Part IV. p. 125—of dipping and horizontal needles at ditto, compared, IV. p. 177.

J

JONES, Mr. THOMAS, his description of an improved hygrometer, 53.

K

KATER, Capt. H. his account of the adjustment of new standard weights and measures of the United Kingdoms, 1.

L

La Canche, a station for signals made on the French coast, observations of, 85.
Lambton, Colonel, an error pointed out in his estimation of the length of the French arc, 568.
Lamp. Lieut. DRUMMOND's construction of one, yielding an intense light, 330.
LARGETEAU, Lieut. C. L., his observations of signals from Fairlight Down, 90.
Life, human, its law of decrement, 281—terms of according to different tables, 204.
Light, bright, for geodætical signals, M. FRESNEL's, 329—Lieut. DRUMMOND's ditto, 330.
——— emitted by incandescent lime, its chemical effects, 333.
Light-houses, a new mode of illuminating proposed, 335.
Lime, its power of emitting a vivid light when intensely heated, 331.
——— "*flame*," a particular kind of, excelling others in this power, 332.
Lithophagi, their mode of penetrating stone considered, 360 *et seq.* —proofs of their employing a solvent, 365.
Longitudes, difference of, how best determined by a series of correspondent observations of signals, 105.
——————— between Greenwich and Paris determined, 126.

INDEX.

M

Machinery, Mr. Babbage's account of a mode of expressing its action by signs, 250.
Magnesia, its power of emitting light when violently heated, 331.
Magnetic influence in the sun's rays, Mr. Christie on, 219.
Magnetic Observations at Port Bowen, by Capt. Parry and Lieut. Foster, Part IV. p. 73, *et seq.*
——— *Rotations*, Mr. Babbage on, 494.
Magnetizing power of the solar rays, Mrs. M. Somerville on, 132.
Mathieu, M., his observations of signals at the observatory at Paris, 83.
Measures and weights, standard, Captain Kater on their adjustment, 1.
Mercury, proofs of its perfect fixity at — 20° Fahr. 488.
Metre, its length in inches of Sir G. Shuckburgh's scale (39·37079) page 1.
Mont Javoult, observations of rockets fired from, 83.
Mortality, annual, according to different tables, 284—law of, expressed by a curve, and its equation, 288.
Mya truncata, its method of burrowing, 349.

N

Naphthaline, its action on sulphuric acid, 140.
Nereides, their mode of burrowing in sand explained, 342.
Nerves, additional proofs of their influence on animal heat, 60.
——— of motion and sensation form a circle with the brain and voluntary muscles, 163-170.
Nicollet, M., his observations of rocket signals from the Observatory of Paris in 1825.

O

Oil of wine, Mr. Hennell's experiments on, 240.
Osler, E. Esq. on burrowing and boring marine animals, 342.

P

Pain, insensibility of certain nerves to, 168, 172.
Parallax of the fixed stars, Mr. Herschel on a new mode of detecting it, 266.
Paris, its longitude from Greenwich determined, 77, 83.
Parry, Capt. his magnetic and other observations at Port Bowen, Part IV. Nos. 3, and 9.
Pearls. Sir E. Home on their production and formation, 338.

Pendulum, its length (39·13929) in British inches, p. 1. Its length at Unst and Leith Fort, 2.
——— *invariable.* Lieut. FOSTER's observations of at Port Bowen, Part IV. No. 2.
——— Capt. SABINE's observations employed to deduce the figure and ellipticity of the earth, 564.
PERKINS, JACOB, Esq. on the compression of water by high degrees of force, 541.
Pholas, its mode of boring explained, 353.
Piezometer for measuring the compression of water described, 542
Pile, voltaic, its action increased, suspended, or reversed, by the temporary action of a stronger pile, of which it forms a part, 412
Piles, secondary, of RITTER, explained, 413.
Poison of the common toad, Dr. J. DAVY on, 127.
Pole Star, its transits employed to detect instrumental derangements by the sun's heat, 440.
Port Bowen, observations at by Capt. PARRY and Lieut. FOSTER, ROSS, &c. Part IV. See FOSTER.
Pounds, Troy and *Avoirdupois*, legally defined, 8.
POWELL, Revd. B. on the radiation of heat through glass screens, 372.
PRICE, Dr. an error in his calculation of the amount of compound interest pointed out, 297.
Protection of ship's copper, 420—of steam boilers, 421.
Pupil, artificial, case of blindness from birth removed by forming, 529.

R

Ram, hydraulic, its action expressed in Mr. BABBAGE's notation, 264.
Radiation of heat through glass screens, Mr. POWELL's experiments on, 372.
Reflexion of the sun's rays employed as a geodætic signal, 327.
Refraction, atmospheric, at Port Bowen, Part IV. No. 9.
Retina, its sensibility retained after 45 years inaction, 529.
RITCHIE, Mr., his experiments on radiation of heat through thin glass considered, 380.
Rocket signals used for determining differences of longitude, 78.
Rotations, electric and magnetic, Mr. BABBAGE on, 494.
——— of electrified bodies over glass, 497.
——— causes of in suspended needles examined, 520.

S

Sabine, Capt. his observations of signals at Lignieres, 85.
————-, his observations of the pendulum discussed by Mr. Airy, 564.
Sandius. Extract of a letter by, on the origin of pearls, 340.
Savary, M. his observations of rocket signals from the observatory of Paris, 83.
Saxicava rugosa, its mode of penetrating stones discussed, 362.
Shell fish. Mr. Dyllwin on their mode of burrowing and boring, 342.
Signals, sun's reflexion used as, and how, 327—a new species of light used for, 330—instance of its application under difficult circumstances, 334.
——— , rocket. See *Rockets.*
Signs used to express the action of machinery, 250.
Slieve Snaght, signals from, observed at Divvis Hill, 334.
Somerville, Mrs. M. on the magnetizing power of the sun's rays, 132.
South, James, Esq. Observations of the positions and distances of 458 double stars, &c. &c. Part I. Vide the Index Catalogue at the end of Part I.
————————, on the discordances of the sun's observed and computed Right Ascension, and description of a seven-feet transit instrument, 423.
Spatangus, its mode of burrowing, 347.
Standard weights and measures, Capt. Kater on their adjustment, 1.
Stars, fixed. Mr. Herschel on their parallax, 266.
——, list of, fit for observations for parallax, 277.
—— *double.* See *double Stars* and the Index Catalogne at the end of Part I.
Sulpho-naphthalic acid, its formation, 141—purification, 146—analysis, 156.
Sulphonaphthalates, 148.
Sulphovinates, Mr. Hennell's experiments on, 245, &c.
Sulphuric acid, its action on naphthaline, 140—on alcohol, 244—its saturating power diminished by union with hydrocarbon, 248—its perfect fixity at common temperatures, 489.
Sun, magnetizing power of its rays, Mrs. Somerville on, 134.
—— effect of on the braces of the Cambridge Transit, 74.
—— magnetic influence in its rays, Mr. Christie on, 219.
—— effect of its rays on Mr. South's transit, 435.

Sun, transits of—comparative observations of at Greenwich, Paris, Dublin, and Blackman-street, 445 *et seq.*—its longitude computed from DELAMBRE's and CARLINI's tables compared with observation, 481—its right ascension observed and computed, discordances of, 423.
Suspension bridges, Mr. GILBERT on their mathematical theory, 202.
Swedish arc of the meridian, its accuracy considered, 571—employed by Mr. AIRY in determining the earth's figure, 570.

T

Tables for facilitating construction of suspension bridges, and for the laying down of catenaries, 212.
——— of mortality and decrement of life, by Dr. YOUNG, 290.
——— of the sun, by CARLINI and DELAMBRE, compared with observation, 481.
Terebella conchilega, its habits and mode of burrowing, 345.
Teredo, causes of its extinction in Britain, 358.
Tension bars, as applied by TROUGHTON to a transit instrument described, 425.
Toad, common, Dr. J. DAVY on, 127—pores in its skin of two kinds, 130—anatomy of, 129.
Transit instrument of Cambridge observatory, 75.
——————— seven feet, Mr. SOUTH's description of a, 423.
——————— effect of its exposure to sun's rays, 435.
Tumour, aneurismal, coagulation of blood in, 189.

V

Vaccination, its effect on the average duration of life, 281.
Vaporization, Mr. FARADAY on the existence of a limit to, 484.
Variation of the needle at Port Bowen, Part IV. 73—diurnal changes of under a reduced directive power, 129.
Vibrations of a needle diminished by sunshine, 219.
Violet solar rays, their power to produce north polarity in steel, 134

W

WARDROP, J. Esq. his account of the case of a lady born blind who received sight at an advanced age by the formation of an artificial pupil, 529.
Water, Mr. PERKINS on compressibility of, 544.
Weights and Measures, Capt. KATER's account of their adjustment, 1.

INDEX.

WOODHOUSE, R. Esq. F. R. S. on the transit instrument of the Cambridge observatory, 75.
Wrotham Hill, a trigonometrical station used for rocket signals in 1825, 78 *et seq.*

Y

YOUNG, Dr. Thomas, For. Sec. R. S. on a formula for expressing the decrement of human life, 281.
YOUNG, Dr. THOMAS, For. Sec. R. S., statement of a comparison of the sun's observed and computed longitudes in 1820, 481.

Z

Zirconia, its power of emitting light when violently heated, 331.

List of Presents.
Meteorological Register.

ERRATA.

Page 262, line 21, for *second*, read, *half second*.
—— 263, line 16, after *diminishing it*, insert, *they then return in a similar manner in an opposite direction*.
—— 263, line 19, instead of *before its termination*, read, *after its commencement*.
—— 268, line 5, for *not all*, read, *not at all*.
—— 274, line 10, for *became*, read, *because*.

From the Press of
W. NICOL,
Cleveland-row, St. James's.

METEOROLOGICAL JOURNAL,

KEPT BY THE ASSISTANT SECRETARY

AT THE APARTMENTS OF THE

ROYAL SOCIETY,

BY ORDER OF THE

PRESIDENT AND COUNCIL.

METEOROLOGICAL JOURNAL

for January, 1825.

1825 January.		Time. H.	M.	Barometer corrected. Inches.	Therm. without. °	Degree of Moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Str.	Weather.
♄	1	8	30	30,079	52	795	49		W	2	Cloudy.
		3	0	30,121	54	765	54		W	1	Cloudy.
☉	2	9	0	29,871	45	824	45		W	1	Fine.
		3	0	29,953	44	964	47		NW	1	Fine.
☾	3	9	0	30,345	38	579	37		W	1	Fine.
		3	0	30,203	45	753	45		W	1	Cloudy.
♂	4	9	0	29,907	51	821	44	0.154	W byN	1	Cloudy.
		3	0	30,062	46	932	46		NW	2	Rain.
☿	5	9	0	30,588	36	685	35	0.020	N byW	1	Cloudy and dark.
		3	30	30,651	38	712	38		N	1	Cloudy.
♃	6	9	0	30,716	32½	843	32		N	1	Fine.
		3	0	30,681	38	712	38		W	1	Fine.
♀	7	9	0	30,521	40	943	35		Wby N	1	Cloudy.
		3	0	30,453	46	966	46		W	1	Rain.
♄	8	9	0	30,714	38	879	37½	0.002	N	1	Fine.
		3	0	30,737	43	785	43		NW	1	Fine.
☉	9	9	0	30,841	39	882	36		N	1	Thick and hazy.
		3	0	30,835	42	868	42		N	1	Cloudy and hazy.
☾	10	9	0	30,833	41	795	40		N by E	1	Cloudy and hazy.
		3	0	30,804	40½	800	41		N	1	Cloudy.
♂	11	9	0	30,732	38	758	36		NE	1	Cloudy.
		2	0	30,721	42	—	42		N	1	Rain.
☿	12	8	30	30,683	34	966	38		NW	1	Foggy.
		3	0	30,631	39	882	39		——	1	Cloudy.
♃	13	9	0	30,558	36	807	36		NW	1	Cloudy and dark.
		3	0	30,481	38	849	38½		W	1	Cloudy.
♀	14	9	0	30,370	39	941	38		W	1	Cloudy.
		3	0	30,308	43	785	43		W	1	Cloudy.
♄	15	9	0	30,237	41	849	41		W	1	Cloudy.
		3	30	30,153	41	822	42		S	1	Cloudy.
☉	16	9	0	29,802	43	895	36		SW	1	Cloudy.
		3	0	29,658	44	868	43		S	1	Rain.

METEOROLOGICAL JOURNAL

for January, 1825.

1825 January.	Time.	Barometer corrected.	Therm. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
	H. M.	Inches.	°	°	°	Inches.	Points.	Str.	
☾ 17	9 0	29,832	36	1000	36	0.012	NW	1	Fine.
	3 0	29,928	42	763	42		W	1	Fine.
♂ 18	9 0	29,416	44	890	37		SW to S b W		Rain; a violent gale.
	3 0	29,321	46	796	46	0.130	W	2	Fine.
☿ 19	9 0	29,459	34	953	33		W	1	Fine.
	3 0	29,461	39	794	48	0.039	W	2	Fine.
♃ 20	9 0	29,583	39	941	36		NW	2	Cloudy.
	3 0	29,598	42	790	43		N	1	Fine.
♀ 21	9 0	29,733	40	829	39		N	2	Cloudy.
	3 0	29,787	40	749	42	0.003	N	2	Showery.
♄ 22	9 0	29,895	36½	984	36		NE	1	Cloudy.
	2 30	30,002	46	750	46		NNE	1	Cloudy.
☉ 23	9 0	30,167	36	968	35		NNE	1	Cloudy.
	3 0	30,147	40	711	41		NE	1	Cloudy.
☾ 24	9 0	30,078	41	767	40		N	1	Cloudy.
	3 0	29,965	39	794	39		NW	1	Cloudy.
♂ 25	9 0	29,627	30	941	35	0.092	NNW	1	Cloudy.
	3 0	29,782	40	714	40		NW	1,2	Fine.
☿ 26	9 0	30,028	33	—	30	0.005	W	1	Cloudy.
	3 0	29,982	39	824	39		SW	1	Rain.
♃ 27	9 0	30,040	45	824	38	0.010	W	2	Cloudy and hazy.
	3 0	30,029	50½	820	51		SW	2	Cloudy.
♀ 28	8 30	30,545	37½	844	37		N	2	Fine.
	3 0	—	—	—	43		—	—	—
♄ 29	9 0	30,720	32	963	32		WNW	—	—
	3 0	30,657	40	886	40		W by N	1	Fine.
☉ 30	9 0	30,488	38	788	33		W	1	Cloudy.
	3 0	30,405	45	777	45		W	2	Cloudy.
☾ 31	9 0	30,479	45	929	44		W	2	Cloudy.
	3 0	30,454	49	907	49		W	1	Cloudy.

METEOROLOGICAL JOURNAL

for February, 1825.

1825 February.		Time. H.	Time. M.	Barometer corrected. Inches.	Therm. without. °	Degree of Moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
♂	1	9	0	30,089	47	769	46		W	1	Cloudy.
		3	0	30,015	47	835	48		W byN	2	Rain.
☿	2	8	30	30,403	34	785	33		W	1	Fine.
		3	0	30,201	43	734	43		W byN	1	Cloudy.
♃	3	9	0	29,486	51	821	42		W	2,3	Rain.
		3	0	29,521	46	614	48	0.012	W	1	Cloudy.
♀	4	9	0	29,632	32	870	30½		N	1	Snow.
		3	0	29,700	34	759	34		W	1	Fine.
♄	5	9	0	29,681	30	730	26		W	1	Fine.
		3	0	29,678	35	758	35		W byN		———
☉	6	9	0	29,962	32	759	31		N byE	1	Fine.
		3	0	30,132	39	735	39		N byE	1	Fine.
☾	7	9	0	30,172	36	839	31½		S	2	Cloudy.
		3	0	29,997	41	849	41		SW	2	Cloudy.
♂	8	9	0	29,978	38½	909	38	0.279	W	1	Cloudy and hazy.
		3	0	29,989	46	796	46		W	1	Fine.
☿	9	9	0	30,326	36	903	34	0.008	W	1	Fine, rather hazy.
		3	0	30,362	44	781	44		W	1	Fine, some thin clouds.
♃	10	9	0	30,466	37	969	36		W	1	Hazy.
		3	0	30,020	48	777	48		W	1	Cloudy.
♀	11	9	0	30,553	40	857	37		W	1	Fine, rather hazy.
		3	0	30,527	47	703	47		W by S		———
♄	12	9	0	30,555	38	849	35		W	1	Hazy.
		3	0	30,525	43	709	44		W	1	Hazy and cloudy.
☉	13	9	0	30,564	33	929	31		SW	1	Thick fog.
		3	0	30,527	39	971	39		W	1	Cloudy and hazy.
☾	14	9	0	30,430	36	903	36½		W	1	Thick fog.
		3	0	30,345	39	882	39		SW	1	Cloudy and hazy.

METEOROLOGICAL JOURNAL

for February, 1825.

1825 February.	Time.		Barometer corrected.	Therm. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
	H.	M.	Inches.	°	°	°	Inches.	Points	Str.	
♂ 15	9	0	30,139	38	970	37		E	1,2	Cloudy and thick haze.
	3	0	30,061	41	959	41		E	2	Cloudy and hazy.
☿ 16	9	0	29,998	40	943	39		W	1	Cloudy.
	3	0	30,003	45	894	45		SW	1	Cloudy.
♃ 17	9	0	30,024	44	927	39	0.005	SW	1	Cloudy.
	3	0	29,950	47	901	47		SSW	1	Cloudy.
♀ 18	9	0	29,972	45	929	45		SSE	1	Cloudy.
	3	0	30,059	47	934	47		S	1	Rain.
♄ 19	9	0	30,234	45	894	44	0.010	ESE	1	Cloudy and hazy.
	3	0	30,206	50	820	50		SE	1	Cloudy.
☉ 20	9	0	30,275	45	859	44		W	1	Cloudy.
	3	0	30,305	51	821	51		W	1	Cloudy.
☾ 21	9	0	30,472	40	943	40		—	—	Thick fog.
	3	0	30,437	47	659	47		W	1	Fine, though hazy.
♂ 22	9	0	30,456	40	915	37½		NE	1	Thick fog.
	3	0	—	45	—	45		—	—	—
☿ 23	9	0	30,197	40	866	39		ESE	1	Cloudy.
	3	0	30,149	42	711	42		E	1	Cloudy.
♃ 24	9	0	30,244	38	788	35½		NE	1	Cloudy.
	3	0	30,265	39	765	42		E	1	Cloudy and dark.
♀ 25	9	0	30,402	38	788	36		ESE	1,2	Cloudy.
	3	0	30,374	40	743	40		NE	1,2	Cloudy.
♄ 26	9	0	30,266	36½	871	35		E	1	Cloudy.
	3	0	30,177	38	849	40		ESE	1	Cloudy.
☉ 27	9	0	29,784	37	938	36		SSE	2	Rain.
	3	0	29,583	43	962	44		S	1	Cloudy.
☾ 28	9	0	29,528	36	806	34	0.078	N	1	Cloudy.
	3	0	29,603	40	629	42		N	1	Fine.

METEOROLOGICAL JOURNAL

for March, 1825.

1825 March.		Time. H.	Time. M.	Barometer corrected. Inches.	Therm. without. °	Degree of Moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
♂	1	9	0	29,735	37	875	33		NW	1	Fine.
		3	0	29,563	45	753	46		SSE	2	Cloudy.
☿	2	9	0	29,209	41	932	36	0.152	W	2	Rain.
		3	0	29,195	46	727	46		W	1,2	Cloudy.
♃	3	9	0	29,429	37	906	34	0.378	W	1	Fine.
		3	0	29,435	43	785	44½		S	1	Fine.
♀	4	9	0	29,627	38	879	35		NW	2	Fine.
		3	0	29,766	42	842	42		N	1	Fine.
♄	5	9	0	30,221	36	806	31		NW	1	Fine.
		3	0	30,254	43	538	44		NW	1	Cloudy.
☉	6	9	0	30,168	40	857	36		NW	1	Cloudy.
		3	0	30,032	43	709	44		SSW	1	Cloudy.
☾	7	9	0	29,661	41	904	38	0.013	SE	1	Cloudy.
		3	0	29,684	45	859	45		S by E	1	Cloudy.
♂	8	9	0	30,213	40	943	39		W	1,2	Cloudy.
		4	0	30,248	46	796	46½		SSW	1	Fine.
☿	9	9	0	30,240	46	909	42		S	1	Rain.
		3	0	30,231	52	823	52	0.026	W by S	1	Cloudy.
♃	10	9	0	30,247	50	910	49		W	1	Cloudy and dark.
		3	0	30,221	46	966	46		W byN	1	Dark and cloudy.
♀	11	9	0	30,146	49	815	48		W	1	Rain.
		3	0	——	—	—	—		——	—	——
♄	12	9	0	30,149	47	835	41		W	1	Fine.
		3	0	——	—	—	50		——	—	——
☉	13	9	0	30,134	43	785	41½	0.010	NNE	1	Cloudy.
		3	0	30,046	43	886	45		E	1	Dark and rain.
☾	14	9	0	30,104	35	658	33	0.024	E by S	1	Rain and sleet.
		3	0	30,090	36	734	36½		E by S	2	Cloudy.
♄	15	9	0	30,174	34	862	33		E	1	Snow.
		3	0	30,223	37	570	38		E	1,2	Cloudy.
☿	16	9	0	30,238	36	710	32		N	2	Cloudy.
		3	0	30,152	39	647	40		N	2	Cloudy.

METEOROLOGICAL JOURNAL

for March, 1825.

1825 March.	Time.	Barometer corrected.	Ther. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
	H. M.	Inches.	°	°	°	Inches.	Points.	Str.	
♃ 17	9 0	30,466	31	630	28		E	1	Fine.
	3 0	30,459	37	449	37		S	1	Fine.
♀ 18	9 0	——	—	—	29		—	1	Fine.
	3 0	30,557	41	541	41		SE	1	Fine.
♄ 19	9 0	30,600	36	758	30		E	1	Fine, with thin clouds.
	3 0	30,548	45	588	45		SE	1	Fine.
☉ 20	9 0	30,536	36	839	32		NE	1	Fine.
	3 0	30,606	48	452	48		E	1	Fine.
☾ 21	9 0	30,579	40	857	34		NE	1	Cloudy.
	3 0	30,478	45	753	47		E	1	Fine.
♂ 22	9 0	30,327	38	879	37		N	1	Cloudy.
	3 0	30,233	40	914	40		E	1,2	Cloudy and dark.
☿ 23	9 0	30,045	42	737	37		E	2	Fine.
	3 0	29,941	44	707	45		E	2	Fine.
♃ 24	9 0	30,048	39	882	33		E	1	Fine.
	3 0	29,945	47	967	47½		SE	1,2	Fine.
♀ 25	9 0	29,918	42	737	37		SSE	1	Fine, rather hazy.
	3 0	29,790	48	638	49		E	1	Fine.
♄ 26	9 0	30,006	45	729	38		SE	1	Fine.
	3 0	30,020	52	486	53		E by S	1	Fine.
☉ 27	9 0	30,041	41	740	36		NE	1	Fine.
	3 0	29,973	51	618	51½		E	1	Fine.
☾ 28	9 0	30,033	45	777	30		NE	1	Hazy and cloudy.
	3 0	30,005	50	760	52		SE	1	Cloudy.
♂ 29	9 0	29,961	41	904	39		E	1	Thick, dark and hazy.
	3 0	29,907	45	824	45		E	1	Thick and cloudy.
☿ 30	9 0	30,018	41	1000	41		E	1	Cloudy and hazy.
	3 0	30,046	44	890	44		E	1	Cloudy, hazy and dark.
♃ 31	9 0	30,256	44	683	37		E	2	Fine.
	3 0	30,258	49	598	50		E	2	Fine.

METEOROLOGICAL JOURNAL

for April, 1825.

April. 1825		Time. H.	M.	Barometer corrected. Inches.	Therm. without. °	Degree of moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Str.	Weather.
♀	1	9	o	30,441	43	633	38		E	1	Fine, rather hazy.
		3	o	30,414	50	—	50		E	1	Fine.
♄	2	9	o	30,465	42	619	34		N	1	Hazy.
		3	o	30,390	54	687	55		E	1	Fine.
☉	3	9	o	30,339	44	807	39		SW	1	Cloudy and hazy.
		3	o	30,248	59	314	59		NNW	1	Fine.
☾	4	9	o	30,233	50	640	41		N	1	Hazy.
		3	o	30,201	61	347	61		N	1	Fine.
♂	5	9	o	30,263	48	745	42		E	1	Fine, rather hazy.
		3	o	30,238	56	691	57		E	2	Fine.
☿	6	9	o	30,336	46	773	40		E	1	Cloudy and hazy.
		3	o	30,312	53	—	53		E	1	Fine.
♃	7	9	o	30,344	49	660	37		E	1	Fine.
		3	o	30,325	53	712	55		E	1	Fine.
♀	8	9	o	30,373	47	769	42		E	1	Fine.
		3	o	30,308	54	687	55		E	1	Fine.
♄	9	9	o	30,231	41½	904	38		N	1	Hazy.
		3	o	30,160	59	626	59		E	1	Hazy.
☉	10	9	o	30,255	52	738	46		NE	1	Fine, rather hazy.
		3	o	30,202	61	589	61		E	1	Fine, rather hazy.
☾	11	9	o	30,102	56	691	47		W	1	Fine thin clouds, rather hazy.
		3	o	—	—	—	—		—	—	—
♂	12	9	o	30,009	55	714	46½	0.007	W	2	Cloudy.
		3	o	30,027	60	522	60		S	2	Cloudy.
☿	13	9	o	30,003	51	573	47		W	1,2	Rain.
		3	o	30,081	53	766	53		N	2	Cloudy.
♃	14	9	o	30,128	57	740	47		W	1	Cloudy.
		3	o	30,046	62	613	63		W	1	Cloudy.
♀	15	9	o	30,138	52	820	47		W	1	Fine.
		3	o	30,117	63	611	64		W	2	Fine.

METEOROLOGICAL JOURNAL

for April, 1825.

1825 April.		Time. H.	Time. M.	Barometer corrected. Inches.	Therm. without. °	Degree of moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
♄	16	9	0	30,081	56	764	46		W	1	Fine.
		3	0	30,036	58	743	66		NW	2	Cloudy.
☉	17	9	0	30,218	49	660	46		NE	2	Cloudy.
		3	0	30,213	53	451	63		N	1	Fine.
☾	18	9	0	30,189	46	568	37		N	2	Fine.
		3	0	30,119	50	470	51		N	2	Cloudy.
♂	19	9	0	30,209	45	612	35		N	1	Fine, rather hazy.
		3	0	30,175	50	485	51		W	1,2	Cloudy.
☿	20	9	0	30,131	50	660	38		W	1	Thin clouds, and hazy.
		3	0	29,948	58	669	58		S	1	Cloudy.
♃	21	9	0	29,952	54	844	48		W	1	Fine.
		3	0	29,837	63	553	63		W	1	Cloudy.
♀	22	9	0	29,600	53	901	51		W	1	Rain.
		3	0	29,531	56	764	58		S	1,2	Cloudy.
♄	23	9	0	29,432	55	840	50	0.179	W	1	Cloudy.
		3	0	29,416	63	553	64		W	1	Fine.
☉	24	9	0	29,372	54	844	51	0.150	W	1	Cloudy.
		3	0	29,356	57	815	60		W	2	Fine, rather hazy.
☾	25	9	0	29,660	56	764	47	0.293	E	1	Cloudy.
		3	0	29,652	63	611	63		S	1	Fine.
♂	26	9	0	29,609	54	817	47	0.074	E	1	Cloudy; thunder at $7^h 45^m$
		3	0	29,537	59	693	59		E	1	Fine. [A. M. and very dark; wind E.
☿	27	9	0	29,273	54	791	51	0.130	E	1	Cloudy.
		3	0	29,187	61	763	59		W	1	Cloudy.
♃	28	9	0	29,344	57	669	45	0.307	E	2	Fine.
		3	0	29,355	60	671	61		SE	2	Fine.
♀	29	9	0	29,455	57	742	51	0.005	SE	1	Cloudy.
		3	0	29,494	63	572	64		S	1	Cloudy.
♄	30	9	0	29,702	55	815	49		S	1	Cloudy.
		4	0	29,727	57	669	61		SSE	2	Cloudy.

METEOROLOGICAL JOURNAL
for May, 1825.

1825 May.		Time. H.	Time. M.	Barometer corrected. Inches.	Therm. without. °	Degree of Moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
☉	1	9	0	29,695	54	765	48		S	2	Rain.
		3	0	29,648	60	586	60		SSE	2	Cloudy.
☾	2	9	0	29,662	56	715	47	0.608	SW	2	Cloudy.
		3	0	29,609	60	629	62		S	1,2	Cloudy.
♂	3	9	0	29,722	58	669	50	0.083	W	2	Fine, with some clouds.
		3	0	29,770	61	569	62		S	2	Fine.
☿	4	9	0	29,916	59	626	50		S	2	Cloudy.
		3	0	29,883	67	538	67		S by E		Fine.
♃	5	9	0	29,813	60	764	59	0.049	E	1	Rain.
		3	0	29,787	67	727	67		SW	1	Fine.
♀	6	9	0	29,773	65	801	60		SSE	1	Cloudy and hazy.
		3	0	29,753	71	638	71½		W	1	Cloudy.
♄	7	9	0	29,782	61	770	57		W	1	Cloudy.
		3	0	29,840	67	572	68		S	1	Fine.
☉	8	9	0	29,890	62	673	54		SSW	2	Fine.
		3	0	29,890	65	591	66		S	2	Showery.
☾	9	9	0	30,051	61	718	49	0.038	W	1	Fine.
		3	0	30,021	66	572	67		NW	1	Fine.
♂	10	9	0	30,034	61	652	50		WNW	1	Fine.
		4	0	29,991	64	629	68		N	1	Fine.
☿	11	9	0	29,980	60	739	50		E	1	Cloudy.
		3	0	29,919	61	742	65		ESE	1	Cloudy; a shower at 2 P.M.
♃	12	9	0	29,808	55	765	47	0.099	E	1	Rain.
		3	0	29,778	56	813	58		SE	1	Rain.
♀	13	9	0	29,870	52	907	52	0.960	E	1	Rain.
		3	0	29,940	55	765	55	0.055	ENE	1,2	Cloudy.
♄	14	9	0	30,150	56	691	42		NW	1	Fine.
		3	0	30,118	59	560	61		N	1	Cloudy.
☉	15	9	0	30,195	53	595	40		N	1	Cloudy.
		3	0	30,096	53	516	53		NE	1	Cloudy.
☾	16	9	0	30,112	55	571	45		NE	1	Cloudy.
		3	0	29,952	55	588	56		NNE	1	Cloudy.

METEOROLOGICAL JOURNAL

for May, 1825.

1825 May.	Time.	Barometer corrected.	Therm. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
	H. M.	Inches.	°	°	°	Inches.	Points.	Str.	
♂ 17	9 0	30,131	53	712	47		NNE	1	Cloudy.
	3 0	30,146	57	599	57½		—	—	
☿ 18	9 0	30,270	53	577	44		E	1	Fine, some clouds.
	4 0	30,219	61	471	62		W	1	Cloudy.
♃ 19	9 0	30,239	56	618	45		NE	1	Cloudy.
	4 0	30,206	58	624	61		SSE	1	Fine.
♀ 20	9 0	30,235	59	626	42		E	1	Cloudy, rather hazy.
	3 0	30,190	63	572	64		E	1	Fine.
♄ 21	9 0	30,153	57	693	44		E	1	Cloudy.
	1 30	30,121	64	621	64		ESE	1	Fine, with thin clouds.
☉ 22	9 0	30,036	64	610	46		E	1	Fine.
	6 0	29,980	63	650	69		E	1	Fine.
☾ 23	9 0	29,926	68	637	54		W	1	Fine, some clouds.
	3 0	29,812	74	442	76		S	1	Cloudy.
♂ 24	9 0	29,738	68	593	56		W	1	Fine.
	3 30	29,695	67	635	70		W	1	Cloudy.
☿ 25	9 0	29,587	65	652	54		SW	2	Fine.
	3 0	29,581	68	538	68		W	1	Fine.
♃ 26	9 0	29,643	61	742	54		W	1,2	Cloudy.
	3 0	29,647	57	740	63		NE	2	Cloudy.
♀ 27	9 0	29,731	53	739	46		NNE	2	Cloudy.
	3 0	29,777	53	739	56		N	2	Cloudy.
♄ 28	9 0	29,872	59	560	44		W	1	Fine.
	3 0	29,818	55	765	61		SE	1	Cloudy.
☉ 29	9 0	29,898	54	661	41½	0.156	SW	1	Cloudy.
	3 0	29,884	55	765	57		S	1	Fine.
☾ 30	9 0	30,016	55	664	45	0.018	NE	1	Fine.
	3 0	30,044	59	648	60		N	1	Cloudy.
♂ 31	9 0	30,309	55	611	42	0.007	NNE	1,2	Cloudy.
	3 30	30,319	57	488	61		NE	1	Cloudy.

METEOROLOGICAL JOURNAL

for June, 1825.

1825 June.		Time. H.	M.	Barometer corrected. Inches.	Therm. without. °	Degree of Moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Str.	Weather.
☿	1	9	0	30,339	62	572	45		W	1	Fine.
		3	0	30,280	66	484	68		W	1	Cloudy.
♃	2	9	0	30,040	61½	672	53½	0.040	SSW	2	Cloudy.
		3	0	29,958	64	651	65		W	2	Cloudy.
♀	3	9	0	29,693	60	714	54	0.002	W	2	Cloudy.
		3	0	29,726	63	696	66		W	2	Cloudy.
♄	4	9	0	29,536	54	900	52		W	1	Rain.
		3	0	29,278	58	905	58		W	1	Cloudy.
☉	5	9	0	29,444	55	664	45		W	1	Cloudy.
		3	0	29,596	56	740	57	0.118	W	1	Cloudy.
☾	6	9	0	29,971	59	538	42		W	1	Fine.
		3	0	29,956	66	466	66		W	1	Fine.
♂	7	9	0	29,873	65	606	53		WSW	—	Fine.
		3	0	29,865	68	573	69		SSW	1	Cloudy.
☿	8	9	0	29,965	63	748	55		SW	1	Cloudy.
		3	0	29,938	71	578	71½		SW	1	Fine.
♃	9	9	0	30,069	64	748	52		W	1	Cloudy.
		3	0	30,092	69	596	73		W	1	Cloudy.
♀	10	9	0	30,280	71	558	54		SW	1	Fine.
		3	0	30,233	75	490	76		W	1	Fine.
♄	11	9	0	30,221	69	639	59		W	1	Cloudy and hazy.
		3	30	30,166	75	561	75½		SSE	1	Fine, clear blue sky.
☉	12	9	0	30,146	75	561	57		E	1	Fine.
		3	0	30,092	81	465	81		N	1	Fine.
☾	13	9	0	30,138	73	620	60		NE	1	Fine.
		3	0	30,131	80	449	81		N	1,2	Fine and clear.
♄	14	9	0	30,273	69	682	57		NE	2	Fine.
		3	0	30,256	76	580	76		E	2	Fine, blue sky.
☿	15	9	0	30,282	68	593	54		N	2	Fine, whitish sky.
		5	0	30,206	71	487	73		E	2	Fine.

METEOROLOGICAL JOURNAL

for June, 1825.

1825 June.	Time. H.	Time. M.	Barometer corrected. Inches.	Therm. without. °	Degree of Moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
♃ 16	9	0	30,180	65	700	51		N	1	Fine.
	3	0	30,115	80	528	80		E	1	Fine.
♀ 17	9	0	30,176	64	774	54		N	2	Cloudy.
	3	0	30,114	70	504	77		E	1	Cloudy.
♄ 18	9	0	30,185	64	535	49		E	1	Fine.
	3	0	30,138	66	504	67		N	2	Fine.
☉ 19	9	0	30,043	64	651	48		SE	1	Cloudy.
	3	0	29,916	71	520	72		SW	1	Fine.
☾ 20	9	0	29,727	59	692	54		W	1	Cloudy.
	3	0	29,727	60	—	66	0.110	S	1	Cloudy; a shower at 1 P.M.
♂ 21	9	0	29,869	61	548	45		N	1	Fine.
	9	0	29,881	59	560	61		W	1	Cloudy.
☿ 22	9	0	30,049	60	564	45		W	1	Fine.
	3	0	30,032	68	421	69		NNW	1	Cloudy.
♃ 23	9	0	30,055	57	622	53		W	1	Cloudy and very dark.
	3	0	30,052	69	456	70		W	1	Cloudy.
♀ 24	9	0	29,991	67	497	52		SW	1	Fine.
	3	0	29,934	71	403	72		WNW	1	Fine.
♄ 25	9	0	29,771	70	457	56		S	1	Cloudy.
	3	0	29,673	66	702	73	0.016	W	2	Showery.
☉ 26	9	0	29,759	63	592	51		W	1	Cloudy.
	3	0	29,769	65	—	66		NW	—	Fine.
☾ 27	9	3	29,784	64	572	48½		W	1	Cloudy.
	3	0	29,780	60	693	66		NW	1	Cloudy.
♂ 28	9	0	29,753	62	721	53	0.125	SSW	2	Cloudy.
	3	0	29,683	63	673	67		S	2	Rain.
☿ 29	9	0	29,713	61	718	51	0.170	W	1	Cloudy.
	3	0	29,719	67	538	69		W	1	Cloudy.
♃ 30	9	0	29,697	61	718	56	0.112	W	1	Cloudy.
	3	0	29,680	67	635	69		W	1	Cloudy.

METEOROLOGICAL JOURNAL

for July, 1825.

July. 1825		Time.	Barometer corrected.	Therm. without.	Degree of moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
		H. M.	Inches.	°	°	°	Inches.	Points.	Str.	
♀	1	9 0	29,762	67	612	54		N	1	Fine.
		3 0	29,814	69	609	71		W	1	Cloudy.
♄	2	9 0	30,125	64	651	51	0.055	NNE	1	Fine.
		3 0	30,143	71	521	68		NW	1	Fine.
☉	3	9 0	30,165	65	936	54		E	1	Cloudy.
		3 0	30,094	72	472	72½		W	1	Fine.
☾	4	9 0	30,138	65	749	60		NE	1	Cloudy and hazy.
		3 0	—	—	—	73		—	—	———
♂	5	9 0	30,263	65	676	59		N	1	Cloudy and hazy.
		3 0	30,244	70	618	70		SW	1	Cloudy.
☿	6	9 0	30,085	64	798	59		N	1	Cloudy.
		3 0	30,062	63	800	67		N	1	Cloudy and showery.
♃	7	9 0	30,026	58	715	51		N	1	Cloudy and dark.
		3 0	29,994	62	653	64		N	1	Cloudy.
♀	8	9 0	29,996	60	850	56		N	2	Cloudy.
		3 0	29,986	65	725	66		N	1,2	Cloudy.
♄	9	9 0	30,034	57	937	54		NE	1	Cloudy and dark.
		3 0	29,974	67	612	67		NE	1	Fine.
☉	10	9 0	29,996	65	773	55		NE	1	Cloudy.
		3 0	29,940	69	556	73		S	2	Cloudy.
☾	11	9 0	29,948	72	579	58		W	1	Fine.
		3 0	29,898	74	506	76		S	1	Fine.
♂	12	8 15	29,959	70	639	60		W	1	Fine.
		3 0	—	—	—	82		W	1	Fine.
☿	13	10 15	30,054	75	525	62		W	1	Fine.
		3 0	30,029	79	512	81		W	1	Fine.
♃	14	9 0	30,115	70	660	61		W	1	Fine.
		3 0	30,044	79	479	80		SW	2	Fine.
♀	15	9 0	29,959	84	439	66		S	2	Fine.
		3 0	29,918	83	410	84		S	2	Fine.
♄	16	7 30	30,108	75	581	68		S	1,2	Fine.
		7 30	30,171	74	579	84		SE	1	Hazy.

METEOROLOGICAL JOURNAL

for July, 1825.

1825 July.	Time.	Barometer corrected.	Therm. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
	H. M.	Inches.	°	°	°	Inches.	Points.	Str.	
☉ 17	9 30	30,208	82	546	66		E	1	Fine, somewhat hazy.
	3 0	30,156	82	437	82½		E	2	Fine.
☾ 18	9 0	30,122	82	527	64		E	1	Rather hazy.
	4 0	30,081	84	548	85½		SE	2	Fine and clear.
♂ 19	9 0	30,127	85	549	78		N	1	Fine.
	3 0	30,120	87	533	89		E	1	Fine.
☿ 20	9 0	30,219	79	660	64		E	2	Fine.
	3 0	30,129	80	580	81		E	2	Fine.
♃ 21	9 0	30,164	67	727	59		E	2	Cloudy.
	3 0	30,161	70	618	72		E	2	Cloudy.
♀ 22	9 0	30,135	66	537	52		NNE	1	Fine.
	3 0	30,023	71	472	72		E	1	Fine.
♄ 23	9 0	29,970	68	—	69		E	1	Fine.
	3 0	29,937	70	523	71		E	1	Fine.
☉ 24	9 0	30,041	65	676	64		N	1	Cloudy.
	3 0	29,999	68	521	68		N	1	Cloudy.
☾ 25	9 0	—	—	—	—		—	—	—
	3 0	30,228	70	410	71		N	1	Cloudy.
♂ 26	9 0	30,243	64	651	55		N	1,2	Cloudy.
	3 0	30,221	67	538	69		N	1	Fine.
☿ 27	9 0	30,226	63	673	56		E	1	Cloudy.
	3 0	30,165	70	538	74		E	1,2	Fine.
♃ 28	9 30	30,129	73	429	55		N	1	Fine.
	3 0	30,091	73	488	77		E	1	Fine.
♀ 29	10 0	30,139	70	520	55		N	1	Fine.
	3 0	—	—	—	—		N	1	Fine.
♄ 30	9 0	30,050	74	850	73		N	1	Fine.
	3 0	30,079	73	660	69½		N	1	Fine.
☉ 31	9 0	—	—	—	—		—	—	—
	3 0	29,898	78	—	78		N		Fine.

METEOROLOGICAL JOURNAL

for August, 1825.

1825 August.		Time. H.	M.	Barometer corrected. Inches.	Therm. without. °	Degree of Moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Str.	Weather.
☾	1	9	0	29,945	70		60		W	1	Fine.
		3	0	29,926	84	357	84		W	1	Fine; rose to 86 after
♂	2	9	0	29,917	73	561	68		W	1	Cloudy. [3 o'clock.
		3	0	29,922	70	660	78		SW	2	Rain.
☿	3	9	0	29,943	68	660	57	0.068	SW	2	Cloudy.
		3	0	29,853	72	521	73		W	2	Fine.
♃	4	10	0	29,528	72	660	64	0.120	W	2	Cloudy; rain at 3 A. M.
		3	0	29,482	73	620	68		SW	2	Rain; a violent gale at 11¼
♀	5	9	0	29,461	66	631	55	0.184	NW	2	Cloudy. [P.M. Bar. 29.119
		3	0	29,519	73		74		SW	1,2	Fine. [Th. 69.
♄	6	9	0	29,605	72		59		SW	1	Rain.
		3	0	29,389	67	635	67		W	1	Cloudy.
☉	7	9	0	29,421	65	630	62		W	1	Cloudy.
		5	0	29,459	67½	635	67		W	1	Rather cloudy.
☾	8	9	0	29,429	68		62	0.141	W	1	Fine.
		3	0	29,621	70	556	72		W	1	Fine.
♂	9	9	0	29,660	67	612	57		W	2	Cloudy.
		3	0	29,635	70	488	71		W	1	Cloudy.
☿	10	9	0	29,678	65	676	54		W	1	Cloudy.
		3	0	29,684	66	655	69		S	1	Cloudy.
♃	11	9	0	29,947	60	793	53		NW	1	Cloudy.
		3	0	29,965	68	615	69		NNW	1	Cloudy.
♀	12	9	0	30,007	65	725	56		W	1	Fine, with thin white clouds.
		3	0	29,937	71	503	72		W	1	Cloudy.
♄	13	9	0								
		3	0								
☉	14	9	0	29,793	70	618	55		W	1	Cloudy.
		3	0								
☾	15	9	0					0.220			
		3	0	29,508	65	700	66		W	1,2	Cloudy.
♂	16	9	0	29,785	62	855	58	0.042	NW	1	Dark and cloudy.
		3	0	29,800	69	660	69		W	1	Cloudy.

METEOROLOGICAL JOURNAL
for August, 1825.

1825 August.	Time.		Barometer corrected.	Therm. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
	H.	M.	Inches.	°	°	°	Inches.	Points.	Str.	
☿ 17	9	0	29,827	65	749	57		W	1	Fine, rather hazy.
	3	0	29,812	69	706	73		W	1	Cloudy.
♃ 18	9	30	29,950	63	774	59	0.005	N	1	Cloudy.
	3	0	30,127	67	727	69		N	1,2	Cloudy.
♀ 19	9	0	30,177	62	774	58		N	1	Cloudy.
	3	0	30,124	63	774	65		N	1	Cloudy.
♄ 20	9	0	30,311	69	575	61		S	1	Fine.
	3	0	——	—	——	—		——	—	——
☉ 21	9	0	30,330	69	596	58		N	1	Fine.
	3	0	——	—	——	—		——	—	——
☾ 22	9	0	——	—	——	—		——	—	——
	3	0	30,200	67	704	69		E	1	Fine and clear.
♂ 23	9	0	30,126	68	799	61		E	1	Fine.
	3	0	30,060	71	661	72		E	1	Fine.
☿ 24	9	0	30,082	64	774	55		E	1	Fine, rather hazy.
	3	0	30,054	72	705	73		E	1	Fine.
♃ 25	9	0	30,199	68	776	55		E	1	Cloudy.
	3	0	30,074	68	729	71		E	1	Fine.
♀ 26	9	0	30,124	66	801	54		E	1	Cloudy.
	3	0	30,105	68	704	70		SE	1	Fine.
♄ 27	9	0	30,052	60	821	60		W	1	Rain.
	3	0	29,985	61	941	61		NE	1	Rain.
☉ 28	9	0	29,948	61	971	55		SE	1	Cloudy.
	3	0	29,923	60	970	65		NW	1	Cloudy.
☾ 29	9	0	29,932	65	853	60	0.397	N	1	Rain.
	3	0	30,010	66	801	66		W	1	Rain.
♂ 30	9	0	30,077	67	777	63		SW	1	Fine, rather hazy.
	3	0	30,033	76	635	77	0.078	SW	1	Fine.
☿ 31	9	0	30,075	68	823	65		W	1	Cloudy and hazy.
	3	0	30,033	75	725	76		E	1	Cloudy.

METEOROLOGICAL JOURNAL

for September, 1825.

1825 September.		Time. H.	M.	Barometer corrected. Inches.	Therm. without. °	Degree of Moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Str.	Weather.
♃	1	9	0	30,071	69	752	61		NNE	1	Fine.
		3	0	30,011	70	598	77		N	1	Fine.
♀	2	9	0	30,140	68	729	62		NNE	1	Cloudy.
		3	0	30,107	72	702	74		N	1	Fine.
♄	3	9	0	30,172	61	949	61		N	1	Cloudy.
		3	0	30,045	69	639	70		——	1	Cloudy.
☉	4	9	0	29,935	61	610	56		S	1	Fine.
		3	0	29,970	66	——	74		W	1	Fine.
☾	5	12	0	30,031	60	764	58		W	1	Cloudy.
		3	0	30,010	61	718	61		N	1	Cloudy.
♂	6	9	0	29,950	62	697	59		NW	1	Fine.
		3	30	29,863	65	725	67		N	1	Cloudy.
☿	7	9	0	29,724	60	793	52		W	1	Fine, somewhat hazy.
		3	0	29,644	68	554	68		W	1	Cloudy.
♃	8	9	0	29,604	61	770	56		W	1	Fine.
		3	0	29,605	68	573	68		SW	1	Fine.
♀	9	9	0	29,687	63	673	53		W	1	Fine.
		3	0	——	—	——	—		——	—	——
♄	10	9	0	29,620	65	676	58		NW	1	Fine, rather cloudy.
		3	0	29,449	69	618	70		S	1,2	Cloudy.
☉	11	9	0	29,540	63	748	60		SSW	1	Cloudy.
		3	0	——	—	——	—		——	—	——
☾	12	9	0	29,708	64	774	58		S	1	Fine, a few clouds.
		3	0	29,818	68	682	69		SSE	2	Cloudy.
♄	13	9	0	——	—	——	—		——	—	——
		3	0	——	—	——	—		——	—	——
☿	14	9	0	29,430	61	971	58		S	1	Cloudy and hazy.
		3	0	29,346	67	753	67		N	1	Rain.
♃	15	9	0	29,532	63	855	61	0.750	W	1	Cloudy.
		3	0	29,629	66	749	67		W	1	Cloudy.

METEOROLOGICAL JOURNAL

for September, 1825.

1825 September.	Time.	Barometer corrected.	Therm. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
	H. M.	Inches.	°	°	°	Inches.	Points.	Str.	
♀ 16	9 0	29,807	64	827	56		S	1	Cloudy.
	3 0	29,788	68	752	69		S	1	Cloudy.
♄ 17	9 0	29,778	69	797	62		SW	1	Cloudy.
	3 0	29,743	68	968	73		SW	1	Rain.
☉ 18	9 0	29,784	67	880	66		SW	1	Cloudy.
	3 0	29,715	66	851	70		SW	1	Cloudy.
☾ 19	9 0	29,749	66	856	63	0.455	SW	1	Cloudy.
	3 0	29,764	69	729	70		SW	2	Cloudy.
♂ 20	9 0	29,752	65	700	61		SSW	1	Cloudy.
	3 0	29,737	70	799	71		S	2	Cloudy.
☿ 21	9 0	29,547	66	801	63	0.040	W	1	Cloudy.
	3 0	29,542	70	726	71		8	1	Fine.
♃ 22	9 0	29,639	64	854	59	0.052	W	1	Cloudy.
	3 0	29,774	64	629	65½		W	1	Cloudy.
♀ 23	9 0	30,008	54	817	50		W	1	Hazy.
	3 0	29,990	63	722	64		SW	1	Cloudy.
♄ 24	9 0	29,986	67	777	59		SW	1	Fine.
	3 0	30,003	67	777	70		W	1	Cloudy.
☉ 25	9 0	30,028	65	826	63		W	1	Cloudy, rather hazy.
	3 0	29,990	69	775	71		NW	1	Fine.
☾ 26	9 0	29,983	61	912	60		NE	1	Rain.
	3 0	29,902	65	801	68	0.562	W	2	Fine.
♂ 27	9 0	30,115	57	874	51		W	1	Fine.
	3 30	30,173	63	748	65		N	1	Fine.
☿ 28	9 0	30,337	52	935	49		NE	1	Cloudy and hazy.
	8 30	30,273	57	937	65			1	Fine.
♃ 29	9 0	30,245	57	843	51		E	1	Fine.
	3 0	30,123	59	717	61		E	1	Fine.
♀ 30	9 0	29,948	52	738	47		E	1	Fine.
	3 0	29,873	59	737	59½		E	1	Fine.

METEOROLOGICAL JOURNAL

for October, 1825.

1825 October.		Time. H.	M.	Barometer corrected. Inches.	Therm. without. °	Degree of moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Str.	Weather.
♄	1	9	0	29,802	58	935	56		W	1	Rain.
		3	0	29,807	62	914	65		W	1	Fine.
☉	2	9	0	29,721	62	855	56		N	1	Rain.
		3	0	—	—	—	—		—	—	———
☽	3	12	0	29,621	60	—	59	0.618	E	1	Rain.
		3	0	29,592	64	881	65		S	1	Fine.
♂	4	9	0	29,309	63	855	58	0.040	SW	1	Cloudy.
		3	0	29,895	66	749	68		SSW	1	Fine.
☿	5	9	0	30,074	61	880	56		S	1	Cloudy.
		3	0	30,060	64	827	65½		S	1	Fine.
♃	6	9	0	30,013	63	826	60	0.055	SSE	2	Cloudy, a gale in the night.
		3	0	29,925	65	773	67		SSE	1	Cloudy.
♀	7	9	0	29,487	59	847	57	0.280	W&SW	3	Cloudy, blowed hard all
		3	0	29,830	61	652	62		W	2	Cloudy. [night.
♄	8	9	0	29,989	60	693	59		NE	1	Fine.
		3	0	29,859	62	721	63		N	1	Fine.
☉	9	9	0	29,884	63	696	51		W	1	Fine.
		3	0	29,934	60	770	62		W	1	Cloudy.
☾	10	9	0	30,184	62	828	58	0.485	W	2	Cloudy.
		3	0	30,215	62	855	63		SW	2	Cloudy.
♂	11	9	0	30,339	61	912	59		W	1	Fine.
		3	0	30,298	63	826	64		W	1	Cloudy.
☿	12	9	0	30,125	58	935	53		E	1	Cloudy.
		3	0	30,024	63	826	65		S	1	Fine.
♃	13	9	0	30,131	59	847	57	0.005	W	1	Cloudy.
		3	0	30,170	63	722	63		NW	1	Cloudy.
♀	14	9	0	30,136	55	870	51		W	1	Fog, a very thick fog at 7
		3	0	—	—	—	63		—	—	——— [A. M.
♄	15	9	0	30,439	51	937	47		W	1	Fine, rather hazy.
		3	0	30,463	56	841	57		NW	1	Fine.
☉	16	9	0	30,492	51	879	44		W	1	Cloudy.
		3	0	30,418	59	818	60		SW	1	Cloudy.

METEOROLOGICAL JOURNAL

for October, 1825.

1825 October.	Time.	Barometer corrected.	Therm. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
	H. M.	Inches.	°	°	°	Inches.	Points.	Str.	
☾ 17	9 0	30,218	52	879	47	0.005	W	1	Cloudy.
	3 0	30,051	56	791	56		W	1	Rain.
♂ 18	9 0	30,108	47	934	42		W	1	Cloudy.
	3 0	29,675	50	760	50	0.020	W	2	Rain.
☿ 19	9 0	*29,347	51	763	48½	0.069	W	1	Cloudy.
	3 0	29,131	52	794	54		W	1,2	Rain.
♃ 20	9 0	29,048	41	877	36	0.272	N	1	Fine.
	3 0	29,148	42	618	43		N	2	Fine.
♀ 21	9 0	29,388	40	743	36		NNW	2	Fine.
	3 0	29,476	44	659	44½		NW	2	Fine.
♄ 22	9 0	29,858	46	830	39		NNE	2	Cloudy and showery.
	3 0	29,971	49	784	50		N	1,2	Fine.
☉ 23	9 0	30,097	38	879	35		NW	1	Fine.
	3 0	30,071	45	753	45		W	1	Fine, thick fog at 12 at noon.
☾ 24	9 0	29,925	49	814	44	0.021	W	1	Cloudy and hazy.
	3 0	29,827	54	713	55		W	1	Cloudy.
♂ 25	9 0	29,904	46	830	41	0.015	W	1,2	Cloudy and hazy.
	3 0	29,900	46	773	47	0.028	NW	2	Cloudy,
☿ 26	9 0	30,074	37	906	33		W	1,2	Hazy.
	3 0	29,989	45	659	45½		W	1	Cloudy and dark.
♃ 27	9 0	30,071	43	924	42		N by E	1	Fine, rather hazy.
	3 0	30,022	47	681	47		NW	2	Cloudy.
♀ 28	9 0	29,981	51	821	45		W	1	Cloudy.
	3 0	29,976	57	677	58		NW	1	Cloudy.
♄ 29	9 0	30,017	55	840	52		W	1	Cloudy.
	3 0	29,919	57	740	50		SW	1	Fine.
☉ 30	9 0	29,961	52	794	43	0.085	W	1	Cloudy.
	3 0	29,856	56	841	56		W	1	Cloudy.
☾ 31	9 0	29,989	48	808	44½		W	1	Fine.
	3 0	29,982	52	794	53		W	1	Cloudy.

* Mercury adheres to one side of the tube, and with difficulty disengaged from it.

METEOROLOGICAL JOURNAL
for November, 1825.

1825 November.		Time.		Barometer corrected.	Therm. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
		H.	M.	Inches.	°	°	°	Inches.	Points.	Str.	
♂	1	9	0	29,933	51	879	46		W	1	Cloudy, rain in the night.
		3	0	29,754	57	815	58		W	1	Cloudy.
☿	2	9	0	29,794	48	777	46	0.050	W	1	Cloudy.
		3	0	29,705	52	738	52		NW	1	Cloudy.
♃	3	9	0	28,947	54	713	49½		SW	3	Fine.
		3	0	28,952	48	840	54		W	1	Rain.
♀	4	9	0	29,525	42	895	39	0.081	NW	1	Fine.
		3	0	29,667	46	—	48		NW	1	Cloudy.
♄	5	9	0	29,954	38	879	35		W	1	Fine.
		3	0	—	—	—	—		—	—	—
☉	6	9	0	29,156	56	789	38	0.030	W	2	Cloudy.
		3	0	29,203	51	705	57		W	1	Cloudy.
☾	7	9	0	29,231	40	771	39	0.006	W	1	Cloudy and hazy.
		3	0	29,236	43	734	44		W	1	Cloudy.
♂	8	9	0	29,374	38	848	33½		SW	1	Cloudy.
		3	0	—	—	—	—		—	—	—
☿	9	9	0	29,066	42	874	38	0.400	W	1	Fine.
		3	0	29,140	43	835	45		W	1,2	Fine.
♃	10	9	0	28,740	42	961	38	0.288	SSW	3	Rain.
		3	0	28,732	42	—	43		N	3	Rain.
♀	11	9	0	29,367	39	824	37	0.212	N	1	Rain.
		3	0	29,427	42	868	42		NE	2	Cloudy.
♄	12	9	0	29,806	36	685	35	0.008	N	1,2	Cloudy.
		3	0	29,845	43	557	44		N	1	Fine.
☉	13	8	30	29,950	31	875	29		NW	1	Hazy.
		3	0	29,899	37	758	37		W	1	Fine, rather hazy.
☾	14	9	0	29,870	40	857	35		N	1	Foggy.
		3	0	29,870	44	1000	46		NNW	1	Fine.
♂	15	9	0	30,094	40	886	35½		N	1	Fine.
		3	0	30,090	42	790	43		N	1	Fine.

METEOROLOGICAL JOURNAL

for November, 1825.

1825 November.	Time.		Barometer corrected.	Therm. without.	Degree of moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Weather.
	H.	M.	Inches.	o	o	o	Inches.	Points.	Str.	
☿ 16	9	o	30,181	35	867	32		NW	1	Foggy.
	3	o	30,171	40	857	40		W	1	Cloudy and dark.
♃ 17	9	o	30,100	40	943	38				Foggy and cloudy.
	3	o	29,961	46	864	46		W	2	Cloudy.
♀ 18	9	o	29,977	39	971	38		Wby N	1	Fine.
	3	o	29,809	48	936	48		S	1,2	Rain.
♄ 19	9	o	29,886	41	816	41	0.102	W	1	Cloudy.
	3	o	29,886	46	796	46		W	1	Fine.
☉ 20	9	o	30,172	36	968	34		W	1	Fine, somewhat hazy.
	3	30	30,160	43	886	43		SW	1	Cloudy and hazy.
☾ 21	9	o	29,784	53	820	43		W	3	Cloudy.
	3	o	29,739	53	793	48		W	2	Rain.
♂ 22	9	o	29,863	39	912	38		W	1	Fine.
	3	o	29,963	44	781	45		N	2	Cloudy.
☿ 23	9	o	30,283	36	871	34		W	1	Hazy and cloudy.
	3	o	30,210	44	805	44		W byN	1	Fine.
♃ 24	9	o	30,161	50	910	44	0.128	N	1	Hazy.
	3	o	30,067	51	908	51		SW	2	Rain.
♀ 25	9	o	30,234	43	962	42	0.118	W	1	Fine.
	3	o	30,277	46	773	47		N byW	1	Fine.
♄ 26	9	o	30,072	45	824	38	0.090	W	1	Cloudy.
	3	o	29,795	50	850	50		W	1	Rain.
☉ 27	9	o	29,949	41	767	40	0.060	W	1	Fine.
	3	o	29,881	45	753	45		W	1	Cloudy.
☾ 28	9	o	29,272	51	908	38	0.035	W	2	Rain.
	3	o	29,151	52	823	53			1	Cloudy.
♂ 29	9	o	28,956	44	963	43		S	1	Fine.
	3	o	29,324	48	968	49		SW	2	Rain.
☿ 30	9	o	29,389	40	959	40	0.048	W	3	Rain; strong N.W. gale in
	3	o	29,568	41	822	40		W	1	Fine. [the night.

METEOROLOGICAL JOURNAL

for December, 1825.

1825 December.		Time. H.	M.	Barometer corrected. Inches.	Therm. without. °	Degree of Moisture by Daniell's Hygrom. °	Sixe's Therm. °	Rain. Inches.	Winds. Points.	Str.	Weather.
♃	1	9	o	29,590	33	929	31		S	1	Foggy.
		3	o	29,448	36	1000	38		W	1	Fine.
♀	2	9	o	28,925	45	824	35	0.283	W	2	Rain.
		3	o	28,996	44	854	46	0.050	W	2	Cloudy.
♄	3	9	o	29,175	41	904	40	0.005	SW	2	Fine.
		3	o	29,234	43	835	35		SW	1	Cloudy.
☉	4	9	o	29,126	40	943	39½	0.042	N	1	Rain.
		3	o	29,231	41	932	41		NNE	1	Cloudy.
☾	5	9	o	29,341	35	967	33½	0.230	N	2	Rain.
		3	o	29,248	42	961	43		N	1	Cloudy.
♂	6	9	o	29,371	47	835	42	0.315	S	1,2	Cloudy.
		3	o	29,341	48	904	49	0.010	SSE	1	Cloudy.
☿	7	9	o	29,197	45	894	42		E	1	Cloudy.
		3	o	29,210	50	790	51		E	1	Cloudy.
♃	8	9	o	29,343	45	894	44		E	2	Cloudy, dark and hazy.
		3	o	29,303	44	854	45		NNE	2	Dark and cloudy.
♀	9	9	o	29,365	45	776	44		E	1	Dark and cloudy.
		3	o	29,434	45	859	45		NE	1	Cloudy and dark.
♄	10	9	o	29,617	44	829	44	0.020	W	1	Cloudy and dark.
		3	o	29,656	45	859	45		W	1	Cloudy.
☉	11	9	o	29,735	43	886	43	0.035	W	1	Cloudy.
		3	o	29,756	45	859	47		W	1	Cloudy.
☾	12	9	o	29,845	41	904	40			1	Very thick fog.
		3	o	29,833	42	1000	42			1	Very thick fog.
♂	13	9	o	29,777	36	936	36	0.005	S	1	Thick fog.
		3	o	29,690	46	830	46		S	1,2	Cloudy and foggy.
☿	14	9	o	29,314	47	868	46	0.185	E	3	Rain.
		3	o	29,265	52	850	52		SE	1	Cloudy.
♃	15	9	o	29,530	38	879	37	0.120	W byN	1	Fine.
		3	o	29,691	41	849	42		NW	1	Fine.
♀	16	9	o	29,660	51	763	40	0.015	W	1	Fine.
		3	o	29,773	51	792	53		W	1	Fine.

METEOROLOGICAL JOURNAL,

for December, 1825.

1825 December.	Time.	Barometer corrected.	Therm. without.	Degree of Moisture by Daniell's Hygrom.	Sixe's Therm.	Rain.	Winds.		Remarks.
	H. M.	Inches.	°	°		Inches.	Points.	Str.	
♄ 17	9 0	29,681	51	850	49		SSW	2	Rain.
	3 0	29,707	51	850	53½		W	1	Cloudy.
☉ 18	9 0	29,640	48	872	44	0.155	S	1,2	Fine.
	3 30	29,560	51	821	51		S	1	Cloudy.
☾ 19	9 0	29,317	49	938	49	0.013	S	2	Rain.
	3 0	29,313	47	901	50		NW	2	Cloudy.
♂ 20	9 0	29,402	45	894	41	0.066	E	1	Fine.
	3 0	29,404	50	——	50		E	1	Fine.
☿ 21	9 0	29,404	50	820	45		E	1	Fine.
	3 0	29,427	51	821	51		E	1	Cloudy.
♃ 22	9 0	29,472	47	967	47	0.080	W	1	Cloudy.
	3 0	29,563	47	967	48		W	1	Cloudy.
♀ 23	9 0	29,829	41	932	40		W	1	Cloudy.
	3 0	29,775	45	929	45		SW	1	Cloudy.
♄ 24	9 0	30,071	37	938	36	0.098	NW	1	Fine.
	7 0	30,094	39	971	43		——		Fine.
☉ 25	9 30	29,710	49	876	39	0.010	SW	2	Rain.
	3 30	29,768	47	703	50		NW	2	Fine.
☾ 26	9 0	29,908	38	879	37		W	1	Cloudy and hazy.
	3 0	29,720	43	861	43		W	1	Cloudy.
♂ 27	9 0	29,841	31	760	30		W	1	Fine, rather hazy.
	3 0	29,777	33	585	33½		NW	1	Fine.
☿ 28	9 0	29,646	32	815	29		NW	1	Cloudy and hazy.
	3 0	29,582	36	782	36		W	1	Cloudy.
♃ 29	9 0	29,546	33	964	33		N	1	Cloudy and dark.
	3 0	29,525	35	933	36		NE	1	Cloudy and dark.
♀ 30	9 0	29,582	33	929	32½		W	1	Cloudy, hazy, and dark.
	3 0	29,610	35	808	36		W	1	Cloudy.
♄ 31	9 0	29,714	28	936	28		W	1	Fine, rather hazy.
	3 30	29,751	35	833	35		W	1	Fine.

1825.	Height of Barometer,* corrected.			Height of Thermometer without.			Degrees of Moisture by Daniell's Hygrometer.			Sixe's thermometer.			Rain.†
	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	
	Inches.	Inches.	Inches.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Inches.
January	30,841	29,321	30,211	54	32	40,8	1000	579	838	54	32	40,3	0,467
February	30,564	29,486	30,127	51	30	40,9	971	614	834	51	26	40,1	0,392
March	30,660	29,195	30,075	52	31	42,4	1000	449	772	53	29	40,6	0,603
April	30,465	29,187	29,975	63	45½	54,2	904	314	668	66	34	51,3	1,145
May	30,319	29,581	29,608	71	52	59,8	907	442	652	71½	40	55,7	2,073
June	30,389	29,278	29,950	81	54	65,9	905	403	604	81	42	61,0	0,693
July	30,263	29,762	30,072	87	57	71,1	937	410	607	89	51	67,4	0,055
August	30,330	29,389	29,883	84	60	67,7	971	357	503	84	53	64,5	1,255
September	30,337	29,346	29,852	72	52	64,1	971	554	753	74	47	62,8	1,859
October	30,492	29,048	29,920	66	37	54,4	937	618	807	68	33	52,7	1,998
November	30,277	28,732	29,699	57	31	44,1	1000	557	843	58	29	42,5	1,656
December	30,094	29,126	29,538	51	28	42,7	1000	585	875	53½	28	41,9	1,737
Whole year			29,909			54,0			729			51,7	13,933

* The quicksilver in the bason of the barometer is 100 feet above the level of low water spring tides at Somerset-place.

† The Rain Gage is 114 feet above the same level, and 75 feet above the surrounding ground.

PHILOSOPHICAL

TRANSACTIONS

OF THE

ROYAL SOCIETY

OF

LONDON.

FOR THE YEAR MDCCCXXVI.

PART IV.

Printed at the Expence of the Board of Longitude.

LONDON:

PRINTED BY W. NICOL, SUCCESSOR TO W. BULMER AND CO.
CLEVELAND-ROW, ST. JAMES'S;
AND SOLD BY G. AND W. NICOL, PALL-MALL, PRINTERS TO THE
ROYAL SOCIETY.

MDCCCXXVI

CONTENTS.

I. *Account of experiments made with an invariable pendulum at the Royal Observatory at Greenwich, and at Port Bowen, on the eastern side of Prince Regent's Inlet. By Lieutenant* HENRY FOSTER, *R. N. F. R. S.* - page 1

II. *Observations on the diurnal variation of the magnetic needle, at the Whale Fish Islands, Davis's Strait. By Lieutenant* HENRY FOSTER, *R. N. F. R. S.* - - 71

III. *Magnetical Observations at Port Bowen, &c. A. D.* 1824-25, *comprehending observations on the diurnal variation and diurnal intensity of the horizontal needle; also on the Dip of the magnetic needle at Woolwich, and at different stations, within the Arctic circle. By Captain* W. E. PARRY, *R. N. F. R. S. and Lieutenant* HENRY FOSTER, *R. N. F. R. S.* 73

IV. *Abstract of the daily variation of the magnetic needle No. 2. By Lieutenant* FOSTER, *R. N. F. R. S.* - - 118

V. *Observations for determining the dip of the magnetic needle. By Captain* W. E. PARRY, *R. N. F. R. S. and Lieutenant* HENRY FOSTER, *R. N. F. R. S.* - - - 126

VI. *Observations on the diurnal changes in the position of the horizontal needle, under a reduced directive power, at Port Bowen,* 1825. *By Lieutenant* HENRY FOSTER, *R. N. F. R. S.* 129

VII. *A comparison of the diurnal changes of intensity in the dipping and horizontal needles, at Port Bowen. By Lieutenant* HENRY FOSTER, *R. N. F. R. S.* - 177

VIII. *Account of the repetition of Mr.* CHRISTIE'S *experiments on the magnetic properties imparted to an iron plate by rotation, at Port Bowen, in May and June,* 1825. *By Lieutenant* HENRY FOSTER, *R. N. F. R. S.; together with Mr.* CHRISTIE'S *remarks thereon.* - - - - 188

IX. *Observations to determine the amount of Atmospherical Refraction at Port Bowen in the Years* 1824-25. *By Captain* W. E. PARRY, *R. N. F. R. S. Lieutenant* HENRY FOSTER, *R. N. F. R. S. and Lieutenant* J. C. ROSS, *R. N. F. L. S.* 206

ERRATA.—PART III.

In Mr. HERSCHEL'S Paper on the Parallax of the Fixed Stars.

Page 272, line 21, for "sin. l" read "sin. λ."
—— 274, line 15, for "sin. l" read "sin. λ."
—— 274, line 17, instead of the equation there set down, read as follows:

$$\text{Sin. } \lambda . \tan. (\odot - l) = \tan. (\pi - \sigma) ; \qquad (2)$$

In consequence of these corrections, the dates in Col. 5 of the table page 277 and 278, which have been inadvertently computed from the erroneous formula, are for the most part incorrect.

Page 347, line 16, for *crest*, read *crust*.
—— 348, line 10, supply a comma after "upon it," and omit one after "covers it."
—— 361, line 3, for "*those*," read "*of those*."
—— *ib.* line 7, for "*the length*," read "*a length*."
—— 365, line 12, for "*particular*," read "*particularly*."
—— 371, line 6, supply a comma after "*ligament*," and omit one after "*cuticle*."

ERRATA.—PART IV.

Page 24, Col. Mean Chron. line 6 from bottom, *for* 2 15 52,44, *read* 2 16 52,44.
And in Col. Mean Clock, last line, *for* 22 20 13,25, *read* 12 20 13,25.
—— 31, The second register of the State of the Barometer on the morning of the 18th of June, *for* Begs. *read* Ends.
—— 73, line 12, *for* encreasing, *read* increasing.
—— 106, opposite April 14th, *insert* A. M.
—— 126, line 11, *for* Appendix, *read* Appendices.
—— 127, wherever the word axis occurs, *read* axes.
—— 151, Col. reading of North End of needle, line 18 from bottom, *erase* the sign (+).
—— 189, line 10 from bottom, *after* figures 3, 4, and 5, *insert* Plate VI.
—— 209, lines 6 and 7 from bottom, *for* Tables VIII. to XI. *read* VII. to XII.

PHILOSOPHICAL TRANSACTIONS.

I. *Account of experiments made with an invariable pendulum at the Royal Observatory at Greenwich, and at Port Bowen, on the eastern side of Prince Regent's Inlet. By Lieutenant* HENRY FOSTER, *R. N. F. R. S.*

Read April 6, 1826.

THE determination of the length of the seconds' pendulum in different latitudes, is a subject, that has long been considered of much interest and importance, but more especially of late years, since the practical problem has received from the ingenuity of Captain HENRY KATER, certain improvements and simplifications, which have rendered its results more accurate than had ever before been obtained.

With the nature of these improvements I had already become acquainted when in H. M. S. Conway, with Captain BASIL HALL, on the South American station, where, as will be seen in the Philosophical Transactions for 1823, several series of experiments were made by that officer and myself. Soon after my appointment to the N. W. Expedition under the command of Captain W. E. PARRY, the Board of Longitude, at the suggestion of Captain KATER, did me the honour

to entrust me with an invariable pendulum; and the details of the observations made with this instrument, together with a statement of all the attendant circumstances, are given in the following pages.

The first set of experiments, which are marked (No. I.), were made at the Royal Observatory at Greenwich, in an apartment to the S. W. of the Transit Room, originally intended, I believe, for the observations of the eclipses of Jupiter's satellites, but upon this occasion kindly appropriated by Mr. POND to my use. This room has a solid stone floor, on which the triangular supports for the pendulum and clock were placed. The roof is low, and being composed of wooden panels, the temperature of the room was materially affected by the state of the weather; on one occasion the thermometer ranged four degrees during the observations, although the light was admitted by a window on the north side.

In the adjustments of the instruments employed in the experiments, I strictly adhered to the mode described by Captain KATER, in his paper read before the Royal Society in June, 1819. The intervals between the coincidences were determined by the disappearance of the white disk on the pendulum of the clock behind the tail-piece of the pendulum, and also by the mean of its disappearance and re-appearance. I was induced to take this additional trouble, in order to remove all possible objections which might be raised as to the accuracy of the result; and partly that I might, by actual trials, furnish materials for putting at rest the controversy on this subject. The method of disappearances has been followed by Captain KATER, and more lately by Captain BASIL

HALL and General Sir THOMAS BRISBANE; that of taking a mean between the disappearance and re-appearance of the disk, has been practised by Mr. GOLDINGHAM at Madras, and by Captain SABINE. Theoretically, the mean of the disappearance and re-appearance, would give the true moment at which the two pendulums coincided at the lowest part of the arc of vibration, were it the object of this problem to determine that moment: but it is not:—the experiment being strictly comparative;—and the method of disappearances accomplishes all that is sought after, with perfect certainty, and with less than half the trouble. It may, however, be useful to know, that both methods give identically the same results; that is to say, the number of vibrations of a pendulum determined by the method of disappearance at one station, compared with the number deduced by the same method at another, give precisely the *same* acceleration or retardation as that which would result from comparing the number of vibrations at the first station, ascertained by taking the mean of disappearance and re-appearance, with those of the second station, ascertained by the *same* method. The results of the experiment contained in the following paper show this very obviously, as follows:

Vibrations by the method of disappearance alone at		Vibrations by the method of mean of disappearance and re-appearance at	
Greenwich, ...	86159,368	Greenwich, ...	86159,500
Port Bowen, ...	86230,172	Port Bowen, ...	86230,313
Acceleration by the method of disappearance . .	= 70,804	Acceleration by the mean of disappearance and re-appearance . . .	= 70,813

The difference of the results amounts only to 9 ten-thousandths of a vibration in 24 hours.

This, it may be observed, is the end and object of the problem; which, as I have before stated, is strictly a comparative one; and the only thing to be insisted upon is, that the *same* method should be followed, and the *same* adjustments of the apparatus strictly adhered to, at all the stations which are to be compared together.

Supposing, however, that the vibrations recorded in the present experiments, ascertained by the one method, were compared with those determined by the other, the results would differ only 0,14 of a vibration in 24 hours; a quantity which does not occasion a difference of two ten-thousandths of an inch in the length of the deduced seconds' pendulum, nor of an unit in the denominator of the fraction expressing the ellipticity.

There are cases, of course, dependant on the relative diameter of the white disk, to that of the tail-piece of the pendulum, in which a greater or less difference than the above would exist between the two methods so compared; but this is of no importance whatever, as the object of the problem is fully accomplished by adhering to the *same* method, whichever it be, at both stations, as before stated. It may not be useless to mention also, that Captain KATER did not adopt the method of disappearances in his comparative experiments, until after innumerable trials of other plans, including that of taking the mean of disappearance and re-appearance of the white disk; all of which he eventually abandoned for that of disappearances alone; and it is certainly to be regretted, that he did not publish an account of these unsuc-

cessful trials, as it might have saved myself and others, much unnecessary labour.

The clock used in these experiments was fitted with a gridiron pendulum, vibrating on knife edges in portions of hollow cylinders of agate, and belonged to the Royal Society. It was put in motion at Greenwich on the 17th of April, 1824, three days previous to the commencement of the experiment, and its rate ascertained by comparisons with the transit clock of the observatory each day at noon, and also during the series, at the commencement and at the conclusion. In these essential observations, I was kindly assisted by Mr. T. Taylor, jun. of the Royal Observatory.

In making the observation of the coincidences, the following mode was pursued.

The pendulum being placed in the Y's, was gently lowered until the knife edges rested on the agate planes; and the sides of the diaphragm placed in the focus of the eye-piece of the small telescope, were made just to coincide with, or embrace those of the tail-piece of the pendulum; and this adjustment was examined previous to every observation. The heights of the barometer, and of the thermometer suspended with its bulb about $\frac{2}{3}$ of the length of the pendulum below its point of suspension, and about $\frac{3}{4}$ of an inch in front of the middle of the bar, were taken and registered at the beginning and end of each set of observations. The pendulum was set in motion, by drawing it gently on one side with a piece of twine fastened to one of the legs of its support, until the point at the end of the tail-piece, was about 1°,2 upon the arc; and a little before the pendulum of the clock attained its highest ascent on that side, the twine was let go, and the pendulum allowed to vibrate freely.

The number of vibrations made by the pendulum in 24 hours reduced to the level of the sea, in vacuo and at a determinate temperature, were computed by the methods detailed in Captain KATER'S paper before referred to.

The second experiment marked (No. II.) was made at Port Bowen, on the eastern side of Prince Regent's Inlet, where the ships passed the winter of 1824–25.

The observatory house, prepared in frame at Deptford, having double walls and roofs, three inches apart, was erected early in October on the north side of the harbour, upwards of a hundred feet above the level of the sea, on a bed of secondary limestone, of which this place is composed; the upper stratum consisted of small loose stones, that could only be removed to the depth of a few inches, below which, it was frozen so hard, that little impression could be made by the action of crows and pickaxes.

The high table land, which characterises this coast, rises directly from the sea, on the south side of the harbour, to the height of between six and seven hundred feet; the upper part, presents a perpendicular cliff of one or two hundred feet, exhibiting alternate black and white horizontal stratifications of secondary limestone; it is also deeply excavated in a variety of places by the action of the weather on its less durable parts, thus giving to its outline the appearance of ruined towers and other ancient edifices. The debris, which has fallen from the upper part of the rock, has formed a steep shelving bank or "talus" along its base, except at those places where its outline is intersected by ravines, and here, projecting points are formed of the materials brought down by the melting of the winter's snow.

To the eastward, at the head of Port Bowen, there is an

extensive water course, and a low flat beach extending a quarter of a mile, and interrupting the high table land for the whole of that space. The land on the north side of the harbour from the head of the Port to Stoney Island (which lies about $\frac{1}{3}$ of a mile to the S. E. of the observatory), is similar in character to that already described on the south. From Stoney Island to the north point of entrance, the coast land is not above 200 feet high, but rises to the height of 900 feet at a little distance in the interior.

The house was placed with its length at right angles to the meridian, and divided into two apartments; one was 10 feet square; the other was five feet wide, 10 feet long, and 10 feet high. For conducting the various observations in the winter, the former of these was lined with a thick woollen cloth called *fearnought;* the floor boarded, and a stove placed in it; the latter, being for the use of the transit instrument, had a slit 18 inches wide cut through the walls and roof, and a large stone placed on the top of a cask filled with sand, formed the pedestal for the instrument.

Previous to the commencement of the experiments with the pendulum, it became necessary to remove the boarded floor, and block up the door opening into the room from the outside: the entrance now being through the slit into the transit room; the door in the middle of the partition between the rooms was protected by screens of canvas and *fearnought* on each side. The surface of the ground was then cleared away to as great a depth as possible, and large flat stones filled in with sand, formed the foundation for the supports of the pendulum and clock: care was also taken, that each support should stand on separate and unconnected stones;

additional solidity was given to the supports, by attaching to the hindmost leg of each, a mass of lead, weighing from 40 to 50 lbs. The clock was now fixed to its support; but the pendulum of experiment remained on board the Hecla, until all the necessary preparations were completed. The small telescope containing the diaphragm, and used to observe the coincidences, was placed at the proper distance ($9\frac{3}{4}$ feet) from the pendulum, on its stand outside of the room, in a porch originally erected for the use of the repeating circle: this stand was sunk so far into the ground, as to bring the object-end of the telescope, on a level with the bob of the pendulum of the clock. An aperture of a foot square was found sufficiently large for observing the coincidences, as well as the face of the clock, when sitting at the telescope, which was sheltered by a screen of canvas from any rush of air into the room, on opening the door of the porch.

A transit instrument made by DOLLOND, of thirty inches focal length, and two inches aperture, was cemented to the pedestal already described, with plaister of Paris, at the latter end of October, and brought accurately into the meridian by the transits of high and low stars. A mark was then set up at the distance of 506 feet, to which it was afterwards always adjusted before making an observation: towards the end of March, the sun's rays caused such an apparent wavering of the meridian mark, as to render its removal necessary, and it was accordingly transferred from the exposed situation where it stood at first, to the opposite side of the harbour, a distance of 6697 feet, where, being fixed in a hollow part of the rock, and completely shaded from the sun, it ever afterwards afforded the means of adjusting the

instrument in a satisfactory manner, being perfectly steady and distinct.

The allowance made for expansion, not being the result of experiments actually made on this particular pendulum, but from the deductions resulting from Captain KATER's experiments on a bar exactly similar, it became important in order to render the experiment strictly comparable with that at Greenwich, to keep the temperature of the room as near as possible to the one in which the previous experiments had been performed in England, namely, 50°. From the smallness of the room it was soon found, that the stove placed within it, produced incessant fluctuations in the temperature; it was therefore removed outside, to about six feet from the north wall of the house, and sunk into the ground level with the foundation of the observatory; built round with stones, and a tent was pitched over it. The room was now warmed by the smoke-pipe passing through it; and, to preserve the temperature of the pendulum more uniform, a large triangular covering of *fearnought* lined with racoon skins, was made to enclose the whole apparatus, except that part of the front required for observation. These arrangements effected the object so far, that the temperature of the room was seldom more than 3°, and frequently not one from 50° during the observations. By a SIXES' self-registering thermometer, the mean range of temperature to which the pendulum was exposed in 24 hours was only 8°, and the extreme not more than 12° during the series in June, whilst that of the atmosphere, varied from 23° to 47° of FAH. without any uniformity.

Under these circumstances the pendulum of experiment was placed in the Y's on the 29th of May, 1825, and the

adjustments finally completed on the 1st of June; the clock put in motion, and the apparatus for measuring the arc of vibration fixed in its place; the barometer and thermometer were also suspended after the manner described in the experiments at Greenwich.

The perfect stability of the point of suspension being of the utmost consequence, spirit levels were arranged on the top of the pendulum frame and clock case, to indicate any giving way in the foundation of their respective supports from the effects of thaw, which at this time very generally prevailed; the foundations however remained solid, and the adjustments were preserved, during the whole course of these experiments, which were not commenced to any good purpose before the 14th of June, owing to an unfavourable change in the weather. This took place on the 7th of June, and was such, as rarely to permit a sight of the sun, and not one glimpse of the stars during the above interval from the 7th to 14th.

In ascertaining the rate of the clock, I was confined to the transits of the sun at noon; of Arcturus and α Lyræ when passing south of the zenith. The sun's transit at midnight could not be taken, in consequence of the undulations of his limb, caused by being too near the top of the high land in that direction; neither could α Lyræ be seen soon after noon, from the general hazy state of the atmosphere at the elevation of 22 degrees. At the time of the sun's transit his rays were prevented from touching any part of the instrument, by a screen of canvas placed between the object-glass of the telescope and the slit in the roof of the house; it had a small hole, through which the observation was made, but being

always covered except at the moment of noon, I had reason to believe that none of the adjustments were ever disturbed. In observing the times of transit, a steady going chronometer made by HENRY FRODSHAM was used, and was found particularly convenient from its beating half seconds. A comparison between the clock and chronometer, was always taken before and after the passage of either sun or star. The time of transits shown by the face of the clock, was then deduced by direct proportion. All the comparisons are given in a separate table.

It occasionally happened, owing to the state of the weather, that one of the stars was partially obscured at the time of its passing the meridian, so as to limit the observation to one or two wires only, whilst the transit of the other, over the whole five was obtained; in such cases the mean of the rates for the clock has been deduced, by giving a value to each, in the ratio of the number of wires observed.

In the observation of the coincidences, the same mode was followed as in the experiments at Greenwich. The temperature of the pendulum, however, was more frequently taken by means of a small telescope, placed outside of the room, at a window to the south, and on the same level with the thermometer, suspended a little below the middle of the pendulum for that purpose.

The weather on the whole was favourable during this series; it became somewhat unsettled toward the close; but as no day passed without at least one transit for the rate of the clock, I had no reason to be dissatisfied with any of the observations taken.

A second series was made in July, under more favourable

circumstances of weather, the results of which, differ only one-tenth of a vibration in 24 hours from those in June. The total number of factors for the first series being 275,5, and for the second 66, a mean in that ratio has finally been taken.

The experiment marked III. was made at the Royal Observatory at Greenwich in November, 1825, after the return of the Expedition.

The number of vibrations in 24 hours, deduced from this experiment, differing more than was likely to arise from errors in observation, being 0,24 of a vibration in excess of the number obtained before leaving England in 1824, I thought it right to repeat the experiment, especially as the rate of the clock appeared to be somewhat unsteady. The results of this repetition, made with the rate of the clock more uniform, being precisely the same, I have not considered it necessary to give them in detail.

The difference alluded to in the number of vibrations of the pendulum in 24 hours, being on that side which would arise from the effects of wear of the knife edge of the pendulum, and which seemed probable, from the fine metallic line distinguishable on the agate planes after its removal, I feel disposed to adopt this explanation; and assuming an equable wear, I have taken the mean of the first and last series, as the actual number of vibrations made at Greenwich, to compare with those at Port Bowen, which being intermediate, of course required no correction on that account.

The results of this comparison are given in a subsequent page preceding the third set of experiments. It will therefore be sufficient to state here, that the ellipticity of the earth deduced from these experiments, appears to be $\frac{1}{309,2}$.

The experiments above described are of a nature to require, at every stage, the utmost degree of care; since an error, very small in apparent amount, either in the observations themselves, or in the subsequent computations, may prove fatal to that minute accuracy, without a due attention to which the nice objects of this problem might easily elude our notice.

It will readily be understood, therefore, by every one conversant with such undertakings, that the observer, besides possessing adequate leisure, must be duly assisted in all parts of his progress by those persons with whom he is associated. And as it has been my good fortune to meet not only with the heartiest encouragement, but also the most efficient co-operation from the Commander of the Expedition, throughout the whole course of these and various other delicate researches, I feel it my duty not less on public grounds, than as a matter of private respect and gratitude, to make this acknowledgment of the source, to which every thing that may appear valuable in these enquiries is justly to be traced.

HENRY FOSTER.

No. I. *Pendulum Experiments at the Royal Observatory at Greenwich*, 1824.

April 1824.

Comparisons of the Clock with the Observatory Transit Clock.

Date.	Time by Clock.	Time by the Observatory Clock.	Mean Time at Greenwich	Clock slow of Mean Time.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
20th Noon	0 17 00	2 55 15,45	1 1 3,07	0 44 3,07
P. M.	3 38 00	6 16 48,84	4 22 3,47	0 44 3,47
21st A. M.	7 12 00	21 53 24,66	7 56 5,96	0 44 5,96
Noon	11 22 00	2 4 6,42	0 6 6,72	0 44 6,72
P. M.	3 50 00	6 33 51,20	4 34 7,38	0 44 7,38
22d A. M.	7 56 00	22 38 00,22	8 40 9,60	0 44 9,60
Noon	11 42 00	2 28 9,48	0 26 10,08	0 44 10,08
P. M.	3 30 00	6 16 47,16	4 14 10,35	0 44 10,35
23d A. M.	8 5 00	22 54 32,95	8 49 12,75	0 44 12,75
Noon	11 22 00	2 12 5,85	0 6 13,25	0 44 13,25
P. M.	3 32 00	6 22 47,40	4 16 13,73	0 44 13,73
24th A. M.	7 38 00	22 31 27,81	8 22 15,56	0 44 15,56
Noon	11 21 00	2 15 5,0	0 5 16,20	0 44 16,20
P. M.	3 37 00	6 31 47,41	4 21 16,57	0 44 16,57
25th A. M.	8 17 00	23 14 33,70	9 1 18,64	0 44 18,64
Noon	11 18 00	2 16 4,20	0 2 19,40	0 44 19,40

From the preceding Table of Comparisons, this, of Rates losing has been deduced.

Time of Comparison.	From 20 to 21	From 20 to 22	From 20 to 23	From 20 to 24	From 20 to 25	From 21 to 22	From 21 to 23	From 21 to 24	From 21 to 25	From 22 to 23	From 22 to 24	From 22 to 25	From 23 to 24	From 23 to 25	From 24 to 25
h.	s.	s.	s	s.	s	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
8 A. M.	——	——	——	——	——	3,53	3,33	3,18	3,13	3,13	3,00	3,00	2,87	2,93	3,00
Noon	3,79	3,55	3,44	3,31	3,29	3,31	3,26	3,16	3,17	3,21	3,08	3,12	2,95	3,08	3,20
4 P. M.	3,88	3,45	3,42	3,27	——	3,01	3,19	3,07	——	3,38	3,10	——	2,83	——	——
Rate in a mean solar day.	3,83	3,50	3,43	3,29	3,29	3,28	3,26	3,14	3,15	3,24	3,06	3,06	2,88	3,00	3,10

Observations of Coincidences at Greenwich, April 1824.

Height above the level of the sea 181,5 feet.

P. M. 20th April, Royal Observatory.
Clock losing at a mean rate $3^s.29$.

Barometer { Beginning 30.21 / Ending . 30.19 } 30.20 mean.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Observed vibra. corr. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Disappearance and Re-app.		Disappearance.	Disappearance and Re-app.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
59	1 29 4	29 8	29 6	1.18	1.140	693	693	.....	.....	2.125	.....	.....
	40 37	40 41	40 39	1.10	1.060	693	693,5	.....	.....	1.838	.....	.....
	52 10	52 15	52 12,5	1.02	0.980	692	693,5	.....	.....	1.571	.....	.....
	2 3 42	3 50	3 46	0.94	0.905	695	695	.....	.....	1.339	.....	.....
	15 17	15 25	15 21	0.87	0.845	694	694	.....	.....	1.168	.....	.....
	26 51	26 59	26 55	0.82	0.790	696	696	.....	.....	1.021	.....	.....
	38 27	38 35	38 31	0.76	0.740	693	693,5	.....	.....	0.896	.....	.....
	50 00	50 9	50 4,5	0.72	0.695	697	697,5	.....	.....	0.790	.....	.....
	3 1 37	1 47	1 42	0.67	0.650	695	695	.....	.....	0.691	.....	.....
59	13 12	13 22	13 17	0.63								
59	Mean.					694,22	694,55	86147,81	86147,92	1.27	86149,08	86149,19

A. M. 21st April, Royal Observatory.
Clock losing at a mean rate $3^s.29$.

Barometer { Beginning 30,02 / Ending . 29,98 } 30,00 mean.

54,5	8 33 20	33 25	33 22,5	1.17	1.125	699	699,5	.....	.....	2.070	.....	.....
	44 59	45 5	45 2	1.08	1.035	698	698,5	.....	.....	1.753	.....	.....
	56 37	56 44	56 40,5	0.99	0.955	700	700,5	.....	.....	1.492	.....	.....
	9 8 17	8 25	8 21	0.92	0.890	699	699,5	.....	.....	1.295	.....	.....
	19 56	20 5	20 0,5	0.86	0.840	699	699,5	.....	.....	1.154	.....	.....
	31 35	31 45	31 40	0.82	0.790	698	699	.....	.....	1.021	.....	.....
	43 13	43 25	43 19	0.76	0.730	699	699,5	.....	.....	0.873	.....	.....
	54 52	55 5	54 58,5	0.70	0.680	702	700	.....	.....	0.757	.....	.....
	10 6 34	6 43	6 38,5	0.66	0.635	696	698	.....	.....	0.661	.....	.....
56,7	18 10	18 23	18 16,5	0.61								
55,6	Mean.					698,89	699,33	86 49,47	86149,62	1.23	86150,70	86150,85

Observations of Coincidences at Greenwich—continued.

Height above the level of the sea 181,5 feet.

P. M. 21st April, Royal Observatory.
Clock losing at a mean rate 3ˢ.29.

Barometer { Beginning 29.90 / Ending .. 29.86 } = 29.88 mean.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Observed vibra. corr. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Disappearance and Re-ap.		Disappearance.	Disappearance and Re-app.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
58,5	1 31 17	31 23	31 20	1.22	1.180	692	691,5	.....	.....	2.278	.....	.....
	42 49	42 54	42 51,5	1.14	1.100	693	693	.....	.....	1.978	.....	.....
	54 22	54 27	54 24,5	1.06	1.025	693	693,5	.....	.....	1.719	.....	.....
	2 5 55	6 1	5 58	0.99	0.955	692	694	.....	.....	1.492	.....	.....
	17 27	17 37	17 32	0.92	0.885	696	695	.....	.....	1.281	.....	.....
	29 3	29 11	29 7	0.85	0.825	694	694	.....	.....	1.113	.....	.....
	40 37	40 45	40 41	0.80	0.775	695	695,5	.....	.....	0.982	.....	.....
	52 12	52 21	52 16,5	0.75	0.725	693	694,5	.....	.....	0.860	.....	.....
	3 3 45	3 57	3 51	0.70	0.675	695	695	.....	.....	0.746	.....	.....
59,9	15 20	15 32	15 26	0.65								
59,2	Mean.					693,67	694	86147,61	86147,73	1.38	86148,99	86149,11

A. M. 22d April 1824, Royal Observatory.
Clock losing at a mean rate 3ˢ.29.

Barometer { Beginning 29,81 / Ending .. 29,84 } = 29,825 mean.

54,5	8 48 32	48 37	48 34,5	1.20	1.160	696	696	.....	.....	2.200	.....	.....
	9 00 8	00 13	00 10,5	1.12	1.080	696	697	.....	.....	1.908	.....	.....
	11 44	11 51	11 47,5	1.04	1.005	698	698	.....	.....	1.652	.....	.....
	23 22	23 29	23 25,5	0.97	0.940	698	696,5	.....	.....	1.446	.....	.....
	35 00	35 4	35 2	0.91	0.875	696	698	.....	.....	1.252	.....	.....
	46 36	46 44	46 40	0.84	0.810	696	697	.....	.....	1.073	.....	.....
	58 12	58 22	58 17	0.78	0.755	696	696	.....	.....	0.931	.....	.....
	10 9 48	9 58	9 53	0.73	0 705	697	697,5	.....	.....	0.812	.....	.....
	21 25	21 36	21 20,5	0.68	0.655	698	697	.....	.....	0.702	.....	.....
58,8	33 3	33 12	33 7,5	0.63								
56,6	Mean.					696,78	697	86148,72	86148,80	1.33	86150,05	86150,13

Observations of Coincidences at Greenwich—continued.

Height above the level of the sea 181,5 feet.

P. M. 22d April 1824, Royal Observatory.
Clock losing at a mean rate 3ˢ.29.

Barometer { Beginning 29,85 / Ending ... 29,87 } 29,86 mean.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. corr. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Disappearance and Re-ap.		Disappearance	Disappearance and Re-app.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
59,5	1 29 55	29 59	29 57	1.20	1.160	690	690,5	.....	.....	2.200	.....	.....
	41 25	41 30	41 27,5	1.12	1.080	691	691,5	.....	.....	1.908	.....	.....
	52 56	53 2	52 59	1.04	1.000	692	692,5	.....	.....	1.635	.....	.....
	2 4 28	4 35	4 31,5	0.96	0.925	691	691,5	.....	.....	1.400	.....	.....
	15 59	16 7	16 3	0.89	0.860	692	692,5	.....	.....	1.210	.....	.....
	27 31	27 40	27 35,5	0.83	0.800	693	692,5	.....	.....	1.046	.....	.....
	39 4	39 12	39 8	0.77	0.745	693	694,5	.....	.....	0.908	.....	.....
	50 37	50 48	50 42,5	0.72	0.695	691	691,5	.....	.....	0.790	.....	.....
	3 2 8	2 20	2 14	0.67	0.645	694	693	.....	.....	0.681	.....	.....
61,0	13 42	13 52	13 47	0.62								
60,2	Mean.					691,89	692,22	86146,97	86147,09	1.31	86148,28	86148,40

A. M. 23d April 1824, Royal Observatory.
Clock losing at a mean rate 3ˢ.29.

Barometer { Beginning 29,44 / Ending ... 29,34 } = 29,39 mean.

53,8	8 47 21	47 25	47 23	1.18	1,135	698	698	.....	.....	2.107	.....	.....
	58 59	59 3	59 1	1.09	1,055	698	699	.....	.....	1.820	.....	.....
	9 10 37	10 43	10 40	1.02	0,985	699	700	.....	.....	1.587	.....	.....
	22 16	22 24	22 20	0.95	0,920	700	699	.....	.....	1.384	.....	.....
	34 56	35 2	34 59	0.89	0,865	699	699,5	.....	.....	1.224	.....	.....
	46 35	46 42	46 38,5	0.84	0,810	699	700	.....	.....	1.073	.....	.....
	57 14	57 23	57 18,5	0.78	0,755	701	700,5	.....	.....	0.932	.....	.....
	10 8 55	9 3	8 59	0.73	0,710	700	700,5	.....	.....	0.824	.....	.....
	20 35	20 44	20 39,5	0.69	0,665	701	701	.....	.....	0.724	.....	.....
53,9	32 16	32 25	32 20,5	0.64								
53,8	Mean.					699,44	699,72	86149,67	86149,76	1.30	86150,97	86151,06

Observations of Coincidences at Greenwich — continued.

Height above the level of the sea 181,5 feet.

P. M. 23d April 1824, Royal Observatory.
Clock losing at a mean rate 3ˢ.29.

Barometer { Beginning 29,17 / Ending...29,12 } = 29,145 mean.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. corr. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Disappearance and Re-ap.		Disappearance.	Disappearance and Re-app.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
52,5	1 25 29	25 31	25 30	1.22	1.180	698	699	.....	.....	2.278	.....	.....
	37 7	37 11	37 9	1.14	1.100	700	700	.....	.....	1.978	.....	.....
	48 47	48 51	48 49	1.06	1.025	699	699,5	.....	.....	1.719	.....	.....
	2 00 26	00 31	00 28,5	0.99	0.965	699	700,5	.....	.....	1.524	.....	.....
	12 5	12 13	12 9	0.94	0.910	700	700,5	.....	.....	1.354	.....	.....
	23 45	23 54	23 49,5	0.88	0.850	701	700,5	.....	.....	1.181	.....	.....
	35 26	35 34	35 30	0.82	0,790	702	703	.....	.....	1.021	.....	.....
	47 8	47 18	47 13	0.76	0.730	702	701,5	.....	.....	0.872	.....	.....
	58 50	58 59	58 54,5	0.70	0.675	701	701,5	.....	.....	0.746	.....	.....
53,2	3 10 31	10 41	10 36	0.65								
52,8	Mean.					700,22	700,67	86149,94	86150,10	1.41	86151,35	86151,51

A. M. 24th April 1824, Royal Observatory.
Clock losing at a mean rate 3ˢ.29.

Barometer { Beginning 29,86 / Ending...29,94 } = 29,90 mean.

51,5	8 41 56	42 1	41 58,5	1.16	1.115	700	700	.....	.....	2.033	.....	.....
	53 36	53 41	53 38,5	1.07	1.025	700	700	.....	.....	1.719	.....	.....
	9 5 16	5 21	5 18,5	0.98	0.950	700	701	.....	.....	1.476	.....	.....
	16 56	17 3	16 59,5	0.92	0.885	700	701	.....	.....	1.281	.....	.....
	28 36	28 45	28 40,5	0.85	0.820	701	700,5	.....	.....	1.100	.....	.....
	40 17	40 25	40 21	0.79	0.765	700	701	.....	.....	0.956	.....	.....
	51 57	52 7	52 2	0.74	0.715	701	700,5	.....	.....	0.835	.....	.....
	10 3 38	3 47	3 42,5	0.69	o 665	701	701,5	.....	.....	0.724	.....	.....
	15 19	15 29	15 24	0.64	0.620	699	700,5	.....	.....	0.629	.....	.....
54,5	26 58	27 11	27 4,5	0.60								
53,0	Mean.					700,22	700,67	86149,94	86150,10	1.19	86151,13	86151,29

Observations of Coincidences at Greenwich—continued.

Height above the level of the sea 181,5 feet.

P. M. 24th April, 1824, Royal Observatory.
Clock losing at a mean rate $3^s.29$.

Barometer { Beginning 30.00 / Ending .. 30.03 } 30.015 mean.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. corr. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Disappearance and Re-app.		Disappearance.	Disappearance and Re-app.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
55,9	1 45 17	45 21	45 19	1.18	1.135	694	695	.....	.....	2.107	.....	.....
	56 51	56 57	56 54	1.09	1.055	696	696	.....	.....	1.820	.....	.....
	2 8 27	8 33	8 30	1.02	0.985	694	694,5	.....	.....	1.587	.....	.....
	20 1	20 8	20 4,5	0.95	0.910	695	696	.....	.....	1.354	.....	.....
	31 36	31 45	31 40,5	0.87	0.845	697	696	.....	.....	1.168	.....	.....
	43 13	43 20	43 16,5	0.82	0.795	695	696	.....	.....	1.034	.....	.....
	54 48	54 57	54 52,5	0.77	0.745	695	696	.....	.....	0.908	.....	.....
	3 6 23	6 34	6 28,5	0.72	0.690	698	697,5	.....	.....	0.779	.....	.....
	18 1	18 11	18 6	0.66	0.640	695	696	.....	.....	0.671	.....	.....
58,0	29 36	29 48	29 42	0.62								
56,9	Mean.					695,44	695,89	86148,24	86148,41	1.27	86149,51	86149,68

A. M. 25th April, 1824, Royal Observatory.
Clock losing at a mean rate $3^s.29$.

Barometer { Beginning 30.05 / Ending ... 30.045 } =30.047 mean.

51,5	8 52 27	52 31	52 29	1.16	1.115	701	701,5	.....	.....	2.033	.....	.....
	9 4 8	4 13	4 10,5	1.07	1.030	701	701	.....	.....	1.735	.....	.....
	15 49	15 54	15 51,5	0.99	0.955	701	702	.....	.....	1.492	.....	.....
	27 30	27 37	27 33,5	0.92	0.885	702	702	.....	.....	1.281	.....	.....
	39 12	39 19	39 15,5	0.85	0.825	701	701,5	.....	.....	1.113	.....	.....
	50 53	51 1	50 57	0.80	0.775	702	702	.....	.....	0.982	.....	.....
	10 2 35	2 43	2 39	0.75	0.725	700	701	.....	.....	0.860	.....	.....
	14 15	14 25	14 20	0.70	0.675	702	701	.....	.....	0.746	.....	.....
	25 57	26 5	26 1	0.65	0.635	701	702	.....	.....	0.661	.....	.....
54,8	37 38	37 48	37 43	0.62								
53,1	Mean.					701,22	701,56	86150,29	86150,41	1.21	86151,50	86151,62

Vibrations of the Pendulum at the Royal Observatory at Greenwich.

The Clock making 86396,71 vibrations at a mean rate in a mean solar day, April 1824.

Date.	Barom.	Therm.	Diff. between Temp. Pend. and 50°.	Vibrations of Pendulum in 24 h. corrected for Arc by		Corrections for Temperature.	Vibrations in 24 hours at temperature of 50°.	
				Disappearance.	Mean of Disap. and Re-app.		Disappearance.	Mean of Disap. and Re-ap.
	Inches.	o	o			vib.		
20th P. M.	30,20	59,0	9,0	86149,08	86149,19	+ 3,81	86152,89	86153,00
21st A. M.	30,00	55,6	5,6	86150,70	86150,85	+ 2,37	86153,07	86153,22
P. M.	29,88	59,2	9,2	86148,99	86149,11	+ 3,89	86152,88	86153,00
22d A. M.	29,82	56,6	6,6	86150,05	86150,13	+ 2,79	86152,84	86152,92
P. M.	29,86	60,2	10,2	86148,28	86148,40	+ 4,31	86152,59	86152,71
23d A. M.	29,39	53,8	3,8	86150,97	86151,06	+ 1,61	86152,58	86152,67
P. M.	29,14	52,8	2,8	86151,35	86151,51	+ 1,18	86152,53	86152,69
24th A. M.	29,90	53,0	3,0	86151,13	86151,29	+ 1,27	86152,40	86152,56
P. M.	30,01	56,9	6,9	86149,51	86149,68	+ 2,29	86152,43	86152,60
25th A. M.	30,05	53,1	3,1	86151,50	86151,62	+ 1,31	86152,81	86152,93
Mean . .	29,82	56,0					86152,70	86152,83

Results.

1824.	Correct Number of Vibrations made by the Pendulum in a mean solar day, by	
	Disappearance.	Mean of Disap. and Re-ap.
From 20th April P. M. to 21st A. M.	86152,44	86152,57
22d	86152,71	86152,82
23d	86152,67	86152,78
24th	86152,72	86152,85
25th	86152,70	86152,83
— 21st — P. M. to 22d A. M.	86152,87	86152,97
23d	86152,75	86152,85
24th	86152,79	86152,91
25th	86152,77	86152,90
— 22d — P. M. to 23d A. M.	86152,63	86152,74
24th	86152,75	86152,89
25th	86152,79	86152,92
— 23d — P. M. to 24th A. M.	86152,87	86153,03
25th	86152,83	86152,98
— 24th — P. M. to 25th A. M.	86152,81	86152,95
Mean	86152,74	86152,87
Barom. 29,82, Ther. 56,0°, Buoyancy	= + 6,06	+ 6,06
Elevation 181,5 feet, Correction $= 0{,}75 \times \frac{6}{10}$ . . .	= + 0,45	+ 0,45
No. of vibra. at Greenwich in vacuo at the level of the sea, temp. 50° of Fah.	86159,25	86159,38

The above correction for buoyancy of the atmosphere, has been deduced from the mean height of the barometer 29,82, and temperature 56°,0, together with the specific gravity of the pendulum supposed to be 8,61. That for elevation, by the duplicate ratio of distances from the earth's centre (3954,583 miles) the ball of the pendulum at Greenwich being $181\frac{1}{2}$ feet above the level of the sea. This was deduced from the Account of the Trigonometrical Survey of Great

Britain; from which it appears that the height of the theodolite above the level of the sea was - 214 feet.

Theodolite above the floor of the transit room	=	38
Floor of transit room above the level of the sea	=	176
Ball of pendulum above floor of transit room	=	$5\frac{1}{2}$
Ball of pendulum above the level of the sea -	=	$181\frac{1}{2}$

From the nature of the eminence, however, on which the pendulum stood, I have taken $\frac{6}{10}$ of the correction so obtained, as the proper correction due to this elevation.

June, 1825.

Experiment II. *at Port Bowen in Prince Regent's Inlet.*

Comparison of Chronometer I. with Clock at Port Bowen—(1st Series.)

Date.	Chronometer.	Clock.	Difference.
	h. m. s.	h. m. s.	h. m. s.
June 14th, P. M.	10 42 8,5	8 14 00	2 28 8,5
——	10 53 8	8 25 00	2 28 8
——	3 6 56	12 39 00	2 27 56
——	3 16 55,5	12 49 00	2 27 55,5
Noon, 15th .	2 2 25	11 35 00	2 27 25
——	2 23 24	11 56 00	2 27 24
P. M. 16th . .	10 56 51,5	8 31 00	2 25 51,5
——	11 6 51	8 41 00	2 25 51
Noon, 17th .	1 4 8,5	11 39 00	2 25 8,5
——	2 26 7,5	12 1 00	2 25 7,5
Noon, 18th .	2 2 1	11 38 00	2 24 1
——	2 23 59	11 59 00	2 23 59
P M. . .	10 27 37,5	8 4 00	2 23 37,5
——	10 37 37,0	8 14 00	2 23 37
——	2 42 25,5	12 19 00	2 23 25,5
——	3 4 24,5	12 41 00	2 23 24,5
Noon, 19th .	2 11 53	11 49 00	2 22 53
——	2 22 52,5	12 00 00	2 22 52,5
P. M. . . .	10 26 30	8 4 00	2 22 30
——	10 36 29,5	8 14 00	2 22 29,5
——	2 32 18,5	12 10 00	2 22 18,5
——	3 4 17	12 42 00	2 22 17
Noon, 20th .	2 4 46	11 43 00	2 21 46
——	2 26 45	12 5 00	2 21 45
P. M. . . .	10 17 23	7 56 00	2 21 23
——	10 38 22	8 17 00	2 21 22
——	2 43 10,5	12 22 00	2 21 10,5
——	2 53 10	12 32 00	2 21 10
Noon, 21st . .	1 56 39	11 36 00	2 20 39
——	2 28 37,5	12 8 00	2 20 37,5
Noon, 22d . .	2 6 31	11 47 00	2 19 31
——	2 27 30	12 8 00	2 19 30
P. M. . . .	10 13 8	7 54 00	2 19 8
——	10 23 7,5	8 4 00	2 19 7,5
——	2 37 55,5	12 19 00	2 18 55,5
——	2 48 55	12 30 00	2 18 55
Noon, 23d . .	2 4 23	11 46 00	2 18 23
——	2 25 22	12 7 00	2 18 22
P. M. . . .	10 11 00	7 53 30	2 18 00
——	10 21 59,5	8 4 00	2 17 59,5
——	2 46 47	12 29 00	2 17 47
——	2 57 46,5	12 40 00	2 17 46,5

Transits observed at Port Bowen, June 1825—(*1st Series.*)

Date.	Stars.	1st Wire observed.	1st Wire corrected.	2nd.	3rd Wire meridian.	4th.	5th.	Mean Chron.	Comparison of Chron. and Clock.	Mean Clock.	Clock at mean Noon.
		h. m. s.	m. s.	m. s.	h. m. s.	m. s.	m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
June 14th	Arcturus . .	.....	....	.....	10 50 27,5	50 55	51 22,5	.....	2 28 8,12	8 22 19,38	(3rd wire.).
P.M.	α Lyræ . . .	3 11 58,5	11 59,4	12 32,5	3 13 5	13 37,75	14 10,5	3 13 5,02	2 27 55,69	12 45 9,33	
	⊙'s 1st Limb	2 13 1,5	.....	13 31	2 13 58,5	14 26,5	14 54,5				
15th	⊙'s 2nd Limb	2 15 19	.....	15 48	2 16 16	16 44	17 12				
	⊙'s Centre .	2 14 10,25	14 11,01	14 39,5	2 15 7,25	15 35,25	16 3,25	2 15 7,25	2 27 24,4	11 47 42,85	11 47 41,29
16th, P.M.	Arcturus . .	.....	.....	42 11,5	10 42 39	.....	.....	.....	2 25 52,21	8 16 46,79	(3rd wire.)
	⊙'s 1st Limb	2 13 30	.....	13 59	2 14 27	14 55,5	15 23				
17th	⊙'s 2nd Limb	2 15 47,9	.....	16 17,2	2 16 45	17 13,5	17 41,5				
	⊙'s Centre .	2 14 38,95	14 39,71	15 8,1	2 15 36	16 4,5	16 32,25	2 15 36,09	2 25 8,0	11 50 28,09	11 50 0,78
	⊙'s 1st Limb	2 13 45	.....	14 14	2 14 42,25	15 10	15 37,2				
18th	⊙'s 2nd Limb	2 16 2	.....	16 31	2 16 59,25	17 27,5	17 56				
	⊙'s Centre .	2 14 53,5	14 54,26	15 22,5	2 15 50,75	16 18,75	16 46,6	2 15 50,59	2 23 59,74	11 51 50,85	11 51 10,52
P.M.	Arcturus . .	.....	.....	.....	.....	.....	10 35,46	.....	2 23 37,07	8 12 8,93	(5th wire.)
——	α Lyræ . . .	2 56 22	56 22,9	56 56	2 57 28,8	58 2	58 34,5	2 57 28,83	2 23 24,81	12 34 4,02	
	⊙'s 1st Limb	2 14 00	.....	14 29	2 14 57,5	15 26	15 53,5				
19th	⊙'s 2nd Limb	2 16 18	.....	16 47	2 17 15	17 43,5	18 12,2				
	⊙'s Centre .	2 15 9	15 9,76	15 38	2 16 6,25	16 34,75	17 2,85	2 16 6,31	2 22 52,81	11 53 13,50	11 52 20,07
P.M.	Arcturus . .	10 30 2	30 2,74	30 30	10 30 57	31 25	31 52	10 30 57,29	2 22 29,78	8 8 27,51	
——	α Lyræ . . .	2 52 28,5	52 29,4	53 2,5	2 53 35,25	54 8	54 41	2 53 35,23	2 22 17,5	12 31 17,73	
20th, P.M.	Arcturus . .	10 26 9	26 9,74	26 37	10 27 4	27 31,5	27 59	10 27 4,21	2 21 22,54	8 5 41,67	
——	α Lyræ . . .	2 48 35	48 35,9	49 9	2 49 41,5	50 14,5	50 47,5	2 49 41,65	2 21 10,33	12 28 31,32	
	⊙'s 1st Limb	2 14 31	.....	15 0,5	2 15 28	15 56,5	16 24,2				
21st	⊙'s 2nd Limb	2 16 50	.....	17 18,5	2 17 46,5	18 15	18 43				
	⊙'s Centre .	2 15 40,5	15 41,26	16 9,5	2 16 37,25	17 5,75	17 33,6	2 16 37,43	2 20 38,06	11 55 59,37	11 54 39,86
	⊙'s 1st Limb	2 14 46	.....	15 15,8	2 15 43,5	16 11,8	16 39,5				
22nd	⊙'s 2nd Limb	2 17 4,5	.....	17 33,5	2 18 1	18 29,7	18 58				
	⊙'s Centre .	2 15 55,25	15 56,01	16 24,65	2 16 52,25	17 20,75	17 48,75	2 15 52,44	2 19 30,51	11 57 21,93	11 55 49,45
P.M.	Arcturus . .	10 18 21,5	18 22,24	18 50	10 19 17,25	19 44,5	20 12	10 19 17,21	2 19 7,69	8 0 9,52	
——	α Lyræ . . .	2 40 47,5	40 48,4	41 21,5	2 41 54,5	42 27,5	43 0,5	2 41 54,48	2 18 55,32	12 22 59,16	
	⊙'s 1st Limb	2 15 1	.....	15 30,5	2 15 58,5	16 26,5	16 54,5				
23rd	⊙'s 2nd Limb	2 17 19,5	.....	17 48,5	2 18 16,5	18 44,5	19 12,7				
	⊙'s Centre .	2 16 10,25	16 11,01	16 39,5	2 17 7,5	17 35,5	18 3,6	2 17 7,43	2 18 22,39	11 58 45,04	11 56 59,66
P.M.	Arcturus . .	10 14 28	14 28,74	14 56	10 15 23,5	15 51	16 18	10 15 23,46	2 17 59,8	7 57 23,66	
——	α Lyræ . . .	2 36 54	36 54,9	37 28	2 38 0,5	38 33,5	39 6,5	2 38 0,65	2 17 47,4	22 20 13,25	

Observation of Coincidences at Port Bowen, June 1825 (1st Series.)

Night, June 14th, 1825, Port Bowen. Hygr. { Temp. 50°.5. Dew P. 36°. } Barr. { Begg. 29.850 temp. of mer. 45° / Endg. 29.850 —— 45° } = 29.918 mean cor. to temp. pend.
Clock gaining at a mean rate 69s.88.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
50,5	9 46 26	46 30	46 28	1.17	1.125	693	696	86220,328	86221,403	2.069	86222,397	86223,472
	57 59	58 9	58 4	1.08	1.040	694	695	86220,687	86221,046	1.768	86222,455	86222,814
	10 9 33	9 45	9 39	1.00	0.960	704	701	86224,227	86223,176	1.507	86225,734	86224,683
	21 17	21 23	21 20	0.92	0.890	698	699	86222,116	86222,470	1.295	86223,411	86223,765
	32 55	33 3	32 59	0.86	0.830	698	698,5	86222,116	86222,293	1.122	86223,238	86223,415
51	44 33	44 42	44 37,5	0.80	0.770	699	699	86222,470	86222,470	0.969	86223,439	86223,439
	56 12	56 21	56 16,5	0.74	0.715	698	699	86222,116	86222,470	0.836	86222,952	86223,306
	11 7 50	8 1	7 55,5	0.69	0.670	698	699	86222,116	86222,470	0.734	86222,850	86223,204
	19 28	19 41	19 34,5	0.65	0.620	699	699,5	86222,470	86222,647	0.628	86223,098	86223,275
51	31 7	31 21	31 14	0.59								
50,83	Mean.										86223,286	86223,486
									Correction for Temp. 0°.83.		+ 0,351	+ 0,351
0,83	Diff. to 50°.								Vibra.. in 24 h. at Temp. 50°.		86223,637	86223,837

Morning, June 15th, 1825, Port Bowen. Hygr. { Temp. 49°,0. Dew Pt. 35°. } Barr. { Begg. 29,850 mer. 45° / Endg. 29,859 — 41° } = 29,922 mean cor. to temp. of pend.
Clock gaining at a mean rate 69s.88.

50,5	1 40 54	40 58	40 56	1.15	1.110	696	697	86221,403	86221,760	2.014	86223,417	86223,774
	52 30	52 36	52 33	1.07	1.025	698	698	86222,116	86222,116	1.718	86223,834	86223,834
	2 4 8	4 14	4 11	0.98	0.950	698	698,5	86222,116	86222,293	1.476	86223,592	86223,769
	15 46	15 53	15 49,5	0.92	0.890	701	701,5	86223,176	86223,352	1.295	86224,471	86224,647
	27 27	27 35	27 31	0.86	0.830	700	700,5	86222,823	86223,000	1.122	86223,945	86224,122
49,1	39 7	39 16	39 11,5	0.80	0.775	700	701	86222,823	86223,176	0.982	86223,805	86224,158
	50 47	50 58	50 52,5	0.75	0.725	700	701,5	86222,823	86223,352	0.859	86223,682	86224,211
	3 2 27	2 41	2 34	0.70	0.675	707	705,5	86225,269	86224,750	0.745	86226,014	86225,495
	14 14	14 25	14 19,5	0.65	0.625	704	704	86224,227	86224,227	0.638	86224,865	86224,865
47	25 58	26 9	26 3,5	0.60								
48,87	Mean.										86224,181	86224,319
									Correction for Temp. 1°.13.		— 0,479	— 0,479
1,13	Diff. to 50°.								Vibra. in 24h at Temp. 50°.		86223,702	86223,840

Observation of Coincidences at Port Bowen (1st Series)—continued.

Forenoon, 15th June, 1825, Port Bowen. Clock gaining at a mean rate 69s.88. Hygr. {Temp. 49°. Dew Pt. 32°. Barr. {Begg. 29.846 mer. 43°.5. Endg. 29.832 — 45° .} = 29.906 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
49	9 7 41	7 45	7 43	1.20	1.160	698	698,5	86222,116	86222,293	2.200	86224,316	86224,493
	19 19	19 24	19 21,5	1.12	1.075	700	700	86222,823	86222,823	1.889	86224,712	86224,712
	30 59	31 4	31 1,5	1.03	0.995	699	700	86222,470	86222,823	1.618	86224,088	86224,441
	42 38	42 45	42 41,5	0.96	0.925	701	700,5	86223,176	86223,000	1.399	86224,575	86224,399
49	54 19	54 25	54 22	0.89	0.860	700	701	86222,823	86223,176	1.209	86224,032	86224,385
	10 5 59	6 7	6 3	0.83	0.800	701	701	86223,176	86223,176	1.046	86224,222	86224,222
49	17 40	17 48	17 44	0.77	0.745	702	702,5	86223,527	86223,703	0.907	86224,434	86224,610
	29 22	29 31	29 26,5	0.72	0.700	701	701,5	86223,176	86223,352	0.801	86223,977	86224,153
	41 3	41 13	41 8	0.68	0.660	702	702	86223,527	86223,527	0.712	86224,239	86224,239
49,2	52 45	52 55	52 50	0.64								
49,05	Mean.										86224,288	86224,406
0,95	Diff. to 50°.							Correction for Temp. 0°.95.			— 0,402	—,402
								Vibrations in 24 h. at Temp. 50°.			86223,886	86224,004

Afternoon, 15th June, 1825, Port Bowen. Clock gaining at a mean rate 69s.88. Hygr. {Temp. 49°. Dew Pt. 30°. Barr. {Begg. 29.799 mer. 44½°. Endg. 29.789 — 43½°.} = 29.857 mean cor. to temp. of pend.

47	1 20 33	20 38	20 35,5	1.12	1.080	701	701	86223,176	86223,176	1.907	86225,083	86225,083
	32 14	32 19	32 16,5	1.04	1.005	702	702,5	86223,527	86223,703	1.650	86225,177	86225,353
	43 56	44 2	43 59	0.97	0.935	703	703,5	86223,878	86224,053	1.429	86225,307	86225,482
	55 39	55 46	55 42,5	0.90	0.870	703	702	86223,878	86223,527	1.237	86225,115	86224,764
46,5	2 7 22	7 27	7 24,5	0.84	0.810	702	703	86223,527	86223,878	1,073	86224,600	86224,951
	19 4	19 11	19 7,5	0.78	0.750	704	704	86224,227	86224,227	0.920	86225,147	86225,147
	30 48	30 55	30 51,5	0.72	0.690	704	705	86224,227	86224,576	0.776	86225,003	86225,352
	42 32	42 41	42 36,5	0.66	0.640	704	704	86224,227	86224,227	0.670	86224,897	86224,897
	54 16	54 25	54 20,5	0.62	0.595	706	706	86224,923	86224,923	0.579	86225,502	86225,502
46	3 6 2	6 11	6 6,5	0.57								
46,5	Mean.										86225,092	86225,170
3,5	Diff. to 50°.							Correction for Temp. 3°.5.			— 1,480	— 1,480
								Vibra. in 24 h. at Temp. 50°.			86223,612	86223,690

Observation of Coincidences at Port Bowen (1st Series)—continued.

Night, 15th June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.

Hygr. { Temp. 44°. / Dew Pt. 31°. } Barr. { Begg. 29.772 mer. 42°.5. / Endg. 29.771 — 44°. } = 29.835 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-ap. pearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
44	9 1 23	1 27	1 25	1.16	1.110	703	703,5	86223,878	86224,053	2.014	86225,892	86226,067
44	13 6	13 11	13 8,5	1.06	1.025	703	703,5	86223,878	86224,053	1.718	86225,596	86225,771
44	24 49	24 55	24 52	0.99	0.955	704	705	86224,227	86224,576	1.491	86225,718	86226,067
44	36 33	36 41	36 37	0.92	0.885	705	704,5	86224,576	86224,402	1.280	86225,856	86225,682
44	48 18	48 25	48 21,5	0.85	0.820	703	704,5	86223,878	86224,402	1.099	86224,977	86225,501
46	10 00 1	00 11	00 6	0.79	0.760	704	704	86224,227	86224,227	0.944	86225,171	86225,171
48	11 45	11 55	11 50	0.73	0.705	703	703,5	86223,878	86224,053	0.812	86224,690	86224,865
50	23 28	23 39	23 33,5	0.68	0.660	702	702,5	86223,527	86223,703	0.712	86224,239	86224,415
50,5	35 10	35 22	35 16	0.64	0.620	701	701,5	86223,176	86223,352	0.628	86223,804	86223,980
50,8	46 51	47 4	46 57,5	0.60								
46,53	Mean.										86225,105	86225,280
3,47	Diff. to 50°.							Correction for Temp. 3°.47.			— 1,468	— 1,468
								Vibrations in 24 h. at Temp. 50°.			86223,637	86223,812

Morning, 16th June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.

Hygr. { Temp. 49°. / Dew Pt. 30°. } Barr. { Begg. 29.781 mer. 45° / Endg. 29.761 — 43° } = 29.836 mean cor. to temp. of pend.

49	12 57 4	57 8	57 6	1.17	1.125	699	699,5	86222,470	86222,647	2.069	86224,539	86224,716
	1 8 43	8 48	8 45,5	1.08	1.040	699	699,5	86222,470	86222,647	1.768	86224,238	86224,415
	20 22	20 28	20 25	1.00	0.965	700	700,5	86222,823	86223,000	1.522	86224,345	86224,522
	32 2	32 9	32 5,5	0.93	0.895	700	700,5	86222,823	86223,000	1.309	86224,132	86224,309
48,2	43 42	43 50	43 46	0.86	0.830	700	701,5	86222,823	86223,352	1.122	86223,945	86224,474
	55 22	55 33	55 27,5	0.80	0 775	704	703	86224,227	86223,878	0.982	86225,209	86224,860
47	2 7 6	7 15	7 10,5	0.75	0.725	700	701	86222,823	86223,176	0.860	86223,683	86224,036
	18 46	18 57	18 51,5	0.70	0.675	702	702	86223,527	86223,527	0.745	86224,272	86224,272
	30 28	30 39	30 33,5	0.65	0.630	704	703,5	86224,227	86224,053	0.649	86224,876	86224,702
47	43 12	43 22	43 17	0.61								
47,8	Mean.										86224,360	86224,478
2,2	Diff. to 50°.							Correction for Temp. 2°.2.			— 0,930	— 0,930
								Vibra. in 24 h. at Temp. 50°.			86223,430	86223,548

Observation of Coincidences at Port Bowen (1st Series)—continued.

Forenoon, 16th June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.

Hygr. { Temp. 47°. / Dew Pt. 38°. } Barr. { Begg. 29.769 mer. 43° / Endg. 29.781 — 45° } = 29.843 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds by Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance	Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
47,2	9 2 57	3 00	2 58,5	1.17	1.125	700	701	86222,823	86223,176	2.069	86224,892	86225,245
49,8	14 37	14 42	14 39,5	1.08	1.040	702	702,5	86223,527	86223,703	1.768	86225,295	86225,471
49,8	26 19	26 25	26 22	1.00	0.965	702	702,5	86223,527	86223,703	1.522	86225,049	86225,225
	38 01	38 8	38 4,5	0.93	0.900	703	703	86223,878	86223,878	1.324	86225,202	86225,202
	49 44	49 51	49 47,5	0.87	0.840	702	703	86223,527	86223,878	1.154	86224,681	86225,032
49,8	10 1 26	1 35	1 30,5	0.81	0.785	704	734	86224,227	86224,227	1.007	86225,234	86225,234
	13 10	13 19	13 14,5	0.76	0.735	702	702	86223,527	86223,527	0.883	86224,410	86224,410
	24 52	25 1	25 56,5	0.71	0.685	703	702,5	86223,878	86223,703	0.766	86224,644	86224,469
	36 35	36 43	36 39	0.66	0.640	702	702,5	86223,527	86223,703	0.670	86224,197	86224,373
49,8	48 17	48 26	48 41,5	0.62								
49,28	Mean.										86224,845	86224,962
0,72	Diff. to 50°.								Correction for Temp. 0°.72.		—0,304	—0,304
									Vibrations in 24 h. at Temp. 50°.		86224,541	86224,658

Afternoon, 16th June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.

Hygr. { Temp. 50°. / Dew Pt. 38°. } Barr. { Begg. 29.800 mer. 46°. / Endg. 29.807 — 46°. } = 29.868 mean cor. to temp. of pend.

49,8	1 29 27	29 30	29 28,5	1.19	1.145	698	698,5	86222,116	86222,293	2.143	86224,259	86224,436
	41 5	41 9	41 7	1.10	1.060	698	698	86222,116	86222,116	1.837	86223,953	86223,953
	52 43	52 47	52 45	1.02	0.980	698	698,5	86222,116	86222,293	1.570	86223,686	86223,863
50,3	2 4 21	4 26	4 23,5	0.94	0.910	698	698,5	86222,116	86222,293	1.354	86223,470	86223,647
	15 59	16 5	16 2	0.88	0.850	699	699,5	86222,470	86222,647	1.178	86223,648	86223,825
50,0	27 38	27 45	27 41,5	0.82	0.790	700	700	86222,823	86222,823	1.020	86223,843	86223,843
49,8	39 18	39 25	39 21,5	0.76	0.735	700	700,5	86222,823	86223,000	0.883	86223,706	86223,883
	50 58	51 6	51 2	0.71	0.685	700	701,5	86222,823	86223,352	0.766	86223,589	86224,118
	3 2 38	2 47	2 43,5	0.66	0.635	700	700	86222,823	86222,823	0.659	86223,482	86223,482
50,0	14 18	14 29	14 23,5	0.61								
49,98	Mean.										86223,737	86223,894
0,02	Diff. to 50°.								Correction for Temp. 0°.02.		—0,008	—0,008
									Vibra. in 24 h. at Temp. 50°.		86223,729	86223,886

Observation of Coincidences at Port Bowen (1st Series)—continued.

Night, 16th June, 1825, Port Bowen.
Clock gaining at a mean rate 69ˢ.88.

Hygr. { Temp. 49°. / Dew Pt. 35°. } Barr. { Begg. 29.794 mer. 45°. / Endg. 29.794 — 45°. } = 29.859 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
49,2	9 47 14	47 17	47 15,5	1.19	1.145	699	699,5	86222,470	86222,647	2.143	86224,613	86224,790
	59 53	59 57	59 55	1.10	1.060	699	699,5	86222,470	86222,647	1.837	86224,307	86224,484
	10 11 32	11 37	11 34,5	1.02	0.980	699	699,5	86222,470	86222,647	1.570	86224,040	86224,217
49	23 11	23 17	23 14	0.94	0.910	699	699,5	86222,470	86222,647	1.354	86223,824	86224,001
	34 50	34 57	34 53,5	0.88	0.850	700	700,5	86222,823	86223,000	1.178	86224,001	86224,178
	45 30	45 38	45 34	0.82	0.790	699	700	86222,470	86222,823	1.020	86223,490	86223,843
49	57 9	57 19	57 14	0.76	0.735	700	700,5	86222,823	86223,000	0.883	86223,706	86223,883
	11 8 49	9 00	8 54,5	0.71	0.690	700	699,5	86222,823	86222,647	0.776	86223,599	86223,423
	20 29	20 39	20 34	0.67	0.645	701	701,5	86223,176	86223,352	0.681	86223,857	86224,033
49,2	32 10	32 21	22 15,5	0.62								
49,1	Mean.										86223,937	86224,095
0,9	Diff. to 50°.								Correction for Temp. 0°.9.		—0,381	—0,381
									Vibrations in 24 h. at Temp. 50°,		86223,556	86223,714

Morning, 17th June, 1825, Port Bowen.
Clock gaining at a mean rate 69ˢ.88.

Hygr. { Temp. 46°. / Dew Pt. 37°. } Barr. { Begg. 29.796 mer. 42°. / Endg. 29.792 — 42°. } = 29.859 mean cor. to temp. of pend.

46	1 32 51	32 55	32 53	1.16	1.120	700	701,5	86222,823	86223,352	2.051	86224,874	86225,403
	44 31	44 38	44 34,5	1.08	1.040	702	701	86223,527	86223,176	1.768	86225,295	86224,944
	56 13	56 18	56 15,5	1.00	0,965	702	703	86223,527	86223,878	1.522	86225,049	86225,400
46	2 7 55	8 2	7 58,5	0.93	0.900	702	702,5	86223,527	86223,703	1.324	86224,851	86225,027
	19 37	19 45	19 41	0.87	0 840	703	703,5	86223,878	86224,053	1.154	86225,032	86225,207
	31 20	31 29	31 24,5	0.81	0.780	704	704,5	86224,227	86224,402	0.995	86225,222	86225,397
46	43 4	43 14	43 9	0.75	0.725	703	703	86223,878	86223,878	0.859	86224,737	86224,737
	54 47	54 57	54 52	0.70	0.675	705	705,5	86224,576	86224,750	0.745	86225,321	86225,495
	3 6 32	6 43	6 37,5	0.65	0.625	705	704,5	86224,576	86224,402	0.638	86225,214	86225,040
46	18 17	18 27	18 22	0.60								
46	Mean.										86225,066	86225,183
4,0	Diff. to 50°.								Correction for Temp. 4°.0.		— 1,692	— 1,692
									Vibra. in 24 h. at Temp. 50°.		86223,374	86223,491

Observation of Coincidences at Port Bowen (1st Series) — continued.

Forenoon, 17th June, 1825, Port Bowen. Hyg^{r}. { Temp. 50°. / Dew Pt. 38°. } Bar^{r}. { Beg^{g}. 29 796 mer. 45°. / End^{g}. 29.800 – 46°.2. } = 29.864 mean cor. to temp. of pend.
Clock gaining at a mean rate 69^{s}.88.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
50,8	9 10 51	10 55	10 53	1.12	1.080	697	697,5	86221,760	86221,938	1.907	86223,667	86223,845
	22 28	22 33	22 30,5	1.04	1.000	698	698	86222,116	86222,116	1.635	86223,751	86223,751
	34 6	34 11	34 8,5	0.96	0.925	698	699	86222,116	86222,470	1.399	86223,515	86223,869
50,5	45 44	45 51	45 47,5	0.89	0.860	700	700	86222,823	86222,823	1.209	86224,032	86224,032
	57 24	57 31	57 27,5	0.83	0.805	699	699,5	86222,470	86222,647	1.059	86223,529	86223,706
	10 9 3	9 11	9 7	0.78	0.755	701	701,5	86223,176	86223,352	0.932	86224,108	86224,284
49,8	20 44	20 53	20 48,5	0.73	0.705	700	700,5	86222,823	86223,000	0.813	86223,636	86223,813
	32 24	32 34	32 29	0.68	0.655	701	701	86223,176	86223,176	0.701	86223,877	86223,877
	44 5	44 15	44 10	0.63	0 610	702	702	86223,527	86223,527	0 608	86224,135	86224,135
50,7	55 47	55 57	55 52	0.59								
50,45	Mean.										86223,806	86223,924
										Correction for Temp. 0°.45.	+ 0,190	+ 0,190
0,45	Diff. to 50°.									Vib. in 24 h. at Temp. 50°.	86223,996	86224,114

Afternoon, 17th June, 1825, Port Bowen. Hyg^{r}. { Temp. 52°. / Dew Pt. 40°. } Bar^{r} { Beg^{g}. 29,812 mer. 47°.8. / End^{g}. 29,820 — 48°. } = 29.882 mean cor. to temp. of pend.
Clock gaining at a mean rate 69^{s}.88.

52,2	1 13 34	13 37	13 35,5	1.17	1.125	694	695	86220,687	86221,046	2.069	86222,756	86223,115
	25 8	25 13	25 10,5	1.08	1.045	696	696	86221,403	86221,403	1.785	86223,188	86223,188
	36 44	36 49	36 46,5	1.01	0.970	698	698	86222,116	86222,116	1.538	86223,654	86223,654
51,8	48 22	48 27	48 24,5	0.93	0.895	696	697	86221,403	86221,760	1.309	86222,712	86223,069
	59 58	00 5	00 1,5	0.86	0.835	699	699	86222,470	86222,470	1.138	86223,608	86223,608
	2 11 37	11 44	11 40,5	0.81	0.785	697	697,5	86221,760	86221,938	1.007	86222,767	86222,945
52,0	23 14	23 22	23 18	0.76	0.735	698	698,5	86222,116	86222,293	0.883	86222,999	86223,176
	34 52	35 1	34 56,5	0.71	0.685	699	698,5	86222,470	86222,293	0.766	86223,236	86223,059
	46 31	46 39	46 35	0.66	0.640	697	698	86221,760	86222,116	0.670	86222,430	86222,786
53,0	58 8	58 18	58 13	0.62								
52,25	Mean.										86223,039	86223,178
										Correction for Temp. 2°.25.	+ 0,952	+ 0,952
2,25	Diff. to 50°.									Vibra. in 24 h. at Temp. 50°.	86223,991	86224,130

Observation of Coincidences at Port Bowen (1st Series)—continued.

Night, 17th June, 1825, Port Bowen. Clock gaining at a mean rate 69s.88. Hygr. { Temp. 52°. Dew Pt. 36°. } Bar. { Begg. 29.828 mer. 45°.5. Endg. 29.847 — 47°. } = 29.905 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Observed vibra. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
51	9 22 52	22 56	22 54	1.19	1.145	697	697	86221,760	86221,760	2.143	86223,903	86223,903
	34 29	34 33	34 31	1.10	1.060	696	697	86221,403	86221,760	1.837	86223,240	86223,597
51,5	57 41	57 49	57 45	0.95	0.985	696	697	86221,403	86221,760	1.586	86222,989	86223,346
	10 9 18	9 27	9 22,5	0.88	0.915	697	697,5	86221,760	86221,938	1.369	86223,129	86223,307
	20 56	21 5	21 00,5	0.82	0.850	698	698	86222,116	86222,116	1.178	86223,294	86223,294
52,5	32 34	32 43	32 38 5	0.75	0.785	698	698	86222,116	86222,116	1.007	86223,123	86223,123
	44 11	44 22	44 16,5	0.70	0.725	697	698	86221,760	86222,116	0.859	86222,619	86222,975
	55 48	56 1	55 54,5	0.66	0.680	697	698	86221,760	86222,116	0.756	86222,516	86222,872
51,5	11 7 26	7 40	7 33	0.62	0.640	698	698,5	86222,116	86222,293	0.670	86222,786	86222,963
51,62	Mean.										86223,066	86223,264
									Correction for Temp. 1°.62.		+ 0,685	+ 0,685
1,62	Diff. to 50°.								Vibra. in 24 h. at Temp. 50°.		86223,751	86223,949

Morning, 18th June, 1825, Port Bowen. Clock gaining at a mean rate 69s.88. Hygr. { Temp. 51°. Dew Pt. 40°. } Bar. { Begg. 29.841 mer. 46°. Begg. 29.841 — 46°. } = 29.908 mean cor. to temp. of pend.

51	12 55 15	55 19	55 17	1.15	1.110	696	696,5	86221,403	86221,582	2.014	86223,417	86223,596
	1 6 51	6 56	6 53,5	1.07	1.030	696	696,5	86221,403	86221,582	1.735	86223,138	86223,317
	18 27	18 33	18 30	0.99	0.960	696	696,5	86221,403	86221,582	1.507	86222,910	86223,089
52	30 3	30 10	30 6,5	0.93	0.900	697	697	86221,760	86221,760	1.324	86223,084	86223,084
	41 40	41 47	41 43,5	0.87	0.835	698	698	86222,116	86222,116	1.138	86223,254	86223,254
	53 18	53 25	53 21,5	0.80	0.775	696	697	86221,403	86221,760	0.982	86222,385	86222,742
51,5	2 4 54	5 3	4 58,5	0.75	0.725	698	698,5	86222,116	86222,293	0.859	86222,975	86223,152
	16 32	16 42	16 37	0.70	0.675	699	699	86222,470	86222,470	0.745	86223,215	86223,215
	28 11	28 21	28 16	0.65	0.625	696	698	86221,403	86222,116	0.638	86222,041	86222,754
51	40 47	41 01	40 54	0.60								
51,37	Mean.										86222,935	86223,134
									Correction for Temp. 1°.37.		+ 0,579	+ 0,579
1,37	Diff. to 50°.								Vibra. in 24 h. at Temp. 50°.		86223,514	86223,713

Observation of Coincidences at Port Bowen (1st Series)—continued.

Forenoon, 18th June 1825, Port Bowen. Clock gaining at a mean rate 69ˢ.88. Hygʳ. {Temp. 51°.5. Dew Pᵗ. 40°. Barʳ. {Begᵍ. 29.871 mer. 45° Endᵍ. 29.885 — 47°} = 29.946 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. Re-ap.	Correct. for Arc.	Observed vibra. cor. for Arc. Disappearance.	Observed vibra. cor. for Arc. Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
51	9 17 48	17 52	17 50	1.17	1.125	696	696	86221,403	86221,403	2.069	86223,472	86223,472
	29 24	29 28	29 26	1 08	1.045	696	696,5	86221,403	86221,582	1.785	86223,188	86223,367
	41 00	41 5	41 2,5	1.01	0.975	698	699	86222,116	86222,470	1.554	86223,670	86224,024
51,2	52 38	52 45	52 41,5	0.94	0.905	699	698,5	86222,470	86222,293	1.339	86223,809	86223,632
	10 4 17	4 23	4 20	0.87	0.845	699	699,5	86222,470	86222,647	1.166	86223,636	86223,813
	15 56	16 3	15 59,5	0.82	0.795	699	699,5	86222,470	86222,647	1.033	86223,503	86223,680
51	27 35	27 43	27 39	0.77	0.745	700	700	86222,823	86222,823	0.907	86223,730	86223,730
	39 15	39 23	39 19	0.72	0.695	697	697,5	86221,760	86221,938	0.788	86222,548	86222,726
	50 52	51 1	50 56,5	0.67	0.645	700	700	86222,823	86222,823	0.680	86223,503	86223,503
51,8	11 2 32	2 41	2 36,5	0.62								
51,25	Mean.										86223,451	86223,550
									Correction for Temp. 1°.25.		+ 0,529	+ 0,529
1,25	Diff. to 50°.								Vibra. in 24 h. at temp. 50°.		86223,980	86224,079

Afternoon, 18th June, 1825, Port Bowen. Clock gaining at a mean rate 69ˢ.88. Hygʳ. {Temp. 52°. Dew Pᵗ. 42°. Bar. {Begᵍ. 29.896 mer. 48° Endᵍ. 29.901 — 48°} = 29.965 mean cor. to temp. of pend.

52,8	1 20 33	20 37	20 35	1.17	1.125	695	695	86221,046	86221,046	2.069	86223,115	86223,115
	32 8	32 12	32 10	1.08	1.040	696	696,5	86221,403	86221,582	1.768	86223,171	86223,350
	43 44	43 49	43 46,5	1.00	0.970	696	697	86221,403	86221,760	1.538	86222,941	86223,298
52,2	55 20	55 27	55 23,5	0.94	0.905	697	697,5	86221,760	86221,938	1.339	86223,099	86223,277
	2 6 57	7 5	7 1	0.87	0.840	698	698	86222,116	86222,116	1.154	86223,270	86223,270
	18 35	18 43	18 39	0.81	0.780	698	698	86222,116	86222,116	0 995	86223,111	86223,111
51,8	30 13	30 21	30 17	0.75	0.725	699	699,5	86222,470	86222,647	0.859	86223,329	86223,506
	41 52	42 1	42 56,5	0.70	0.675	700	700	86222,823	86222,823	0.745	86223,568	86223,568
	53 32	53 41	53 36,5	0.65	0.630	698	699	86222,116	86222,470	0.649	86222,765	86223,119
51,2	3 5 10	5 21	5 15,5	0.61								
52,0	Mean.										86223,152	86223,290
									Correction for Temp. 2°.0.		+ 0,846	+ 0,846
2,0	Diff. to 50°.								Vibra. in 24 h. at Temp. 50°.		86223,998	86224,136

Observation of Coincidences at Port Bowen (1st Series)—continued.

Night, 18th June, 1825, Port Bowen. Clock gaining at a mean rate 69ˢ.88. Hygʳ. {Temp. 52°. Dew Pt. 40°. Barʳ. {Begˢ. 29.900 mer. 46°.5. Endˢ. 29.898 — 45°. } = 29.964 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
51,5	8 59 43	59 47	59 45	1.19	1.145	697	697	86221,760	86221,760	2.143	86223,903	86223,903
	9 11 20	11 24	11 22	1.10	1.060	695	695,5	86221,046	86221,225	1.837	86222,883	86223,062
	22 55	23 00	22 57,5	1.02	0.985	697	698	86221,760	86222,116	1.586	86223,346	86223,702
51,0	34 32	34 39	34 35,5	0.95	0.920	697	697	86221,760	86221,760	1.384	86223,144	86223,144
	46 9	46 16	46 12,5	0.89	0.860	698	698,5	86222,116	86222,293	1.209	86223,325	86223,502
	57 47	57 55	57 51	0.83	0.805	698	698	86222,116	86222,116	1.059	86223,175	86223,175
50,8	10 9 25	9 34	9 29	0.78	0.750	698	699	86222,116	86222,470	0.920	86223,036	86223,390
	21 3	21 13	21 8	0.72	0.690	699	699,5	86222,470	86222,647	0.776	86223,246	86223,423
	32 42	32 53	32 47,5	0.66	0.640	700	699	86222,823	86222,470	0.670	86223,493	86223,140
51,3	44 22	44 31	44 26,5	0.62								
51,15	Mean.										86223,283	86223,382
1,15	Diff. to 50°.							Correction for Temp. 1°.15.			+ 0,487	+ 0,487
								Vibra. in 24 h. at Temp. 50°.			86223,770	86223,869

Morning, 19th June, 1825, Port Bowen. Clock gaining at a mean rate 69ˢ.88. Hygʳ. {Temp. 51°. Dew Pt. 40°. Barʳ. {Begˢ. 29.895 mer. 45.°. Endˢ. 29.878 — 44°.2. } = 29.956 mean cor. to temp. of pend.

51,0	1 13 59	14 3	14 1	1.18								
50,8	25 34	25 40	25 37	1.09	1.135	695	696	86221,046	86221,403	2.106	86223,152	86223,509
50,4	37 10	37 17	37 13,5	1.02	1.055	696	696,5	86221,403	86221,582	1.820	86223,223	86223,402
50,0	48 48	48 55	48 51,5	0.95	0.985	698	698	86222,116	86222,116	1.586	86223,702	86223,702
51,0	2 00 26	00 33	00 29,5	0.88	0.915	698	698	86222,116	86222,116	1.369	86223,485	86223,485
52,0	12 3	12 12	12 7,5	0.82	0.850	697	698	86221,760	86222,116	1.178	86222,938	86223,294
52,2	23 40	23 49	23 44,5	0.77	0.795	697	697	86221,760	86221,760	1.033	86222,793	86222,793
51,5	35 17	35 27	35 22	0.72	0.745	697	697,5	86221,760	86221,938	0.907	86222,667	86222,845
51,4	46 55	47 6	47 00,5	0.67	0.695	698	698,5	86222,116	86222,293	0.788	86222,904	86223,081
51,1	58 34	58 45	58 39,5	0.62	0.645	699	699	86222,470	86222,470	0.680	86223,150	86223,150
51,14	Mean.										86223,113	86223,251
1,14	Diff. to 50°.							Correction for Temp. 1.°14.			+ 0,482	+ 0,482
								Vibra. in 24 h. at Temp. 50°.			86223,595	86223,733

Observation of Coincidences at Port Bowen (1st Series)—continued.

Forenoon, June 19th, 1825, Port Bowen. Hyg^{r}. {Temp. 52°.5. Dew Pt. 42°.} Bar^{r}. {Beg^{g}. 29.823 mer. 47°. End^{g}. 29.800 — 48°.} = 29.877 mean cor. to temp. of pend.
Clock gaining at a mean rate 69^{s}.88.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Disap. & Re-ap.	Observed vibra. in 24 h. by Disappear.	Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappear.	Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
52,5	9 16 50	16 54	16 52	1.18	1.140	695	695,5	86221,046	86221,225	2,125	86223,171	86223,350
	28 25	28 30	28 27,5	1.10	1.060	695	695,5	86221,046	86221,225	1,837	86222,883	86223,062
	40 00	40 6	40 3	1.02	0.985	697	697	86221,760	86221,760	1,586	86223,346	86223,346
52,0	51 37	51 43	51 40	0.95	0.920	697	697,5	86221,760	86221,938	1,384	86223,144	86223,322
	10 3 14	3 21	3 17,5	0.89	0.860	697	697,5	86221,760	86221,938	1,209	86222,969	86223,147
	14 51	14 59	14 55	0.83	0.800	697	697,5	86221,760	86221,938	1,046	86222,806	86222,984
51,8	26 28	26 37	26 32,5	0.77	0.745	696	698	86221,403	86222,116	0,907	86222,310	86223,023
	38 4	38 17	38 10,5	0.72	0.690	704	702	86224,227	86223,527	0,776	86225,003	86224,303
	49 48	49 57	49 52,5	0.66	0.635	698	699	86222,116	86222,470	0,659	86222,775	86223,129
51,2	11 1 26	1 37	1 31,5	0.61								
51,87	Mean.										86223,156	86223,296
1,87	Diff. to 50°.							Correction for Temp. 1°.87.			+ 0,790	+ 0,790
								Vibra. in 24 h. at Temp. 50°.			86223,946	86224,086

Afternoon, 19th June, 1825, Port Bowen. Hyg^{r}. {Temp. 52°.5. Dew Pt. 42°.} Bar^{r}. {Beg^{g}. 29.784 mer. 48°. End^{g}. 29.770 — 48.2°.} = 29.842 mean cor. to temp. of pend.
Clock gaining at a mean rate 69^{s}.88.

52,5	1 24 31	24 35	24 33	1.10	1.055	695	696	86221,046	86221,403	1.820	86222,866	86223,223
	36 6	36 12	36 9	1.01	0.970	697	697,5	86221,760	86221,938	1.538	86223,298	86223,476
	47 43	47 50	47 46,5	0.93	0.890	698	697,5	86222,116	86221,938	1.295	86223,411	86223,233
52,2	59 21	59 27	59 24	0.85	0.825	697	697,5	86221,760	86221,938	1.110	86222,870	86223,048
	2 10 58	11 5	11 1,5	0.80	0.775	698	698	86222,116	86222,116	0.982	86223,098	86223,098
	22 36	22 43	22 39,5	0.75	0.725	698	699	86222,116	86222,470	0.859	86222,975	86223,329
51,8	34 14	34 23	34 18,5	0.70	0.675	698	699	86222,116	86222,470	0.745	86222,861	86223,215
	45 52	46 3	45 57,5	0.65	0.630	700	699	86222,823	86222,470	0.649	86223,472	86223,119
	57 32	57 41	57 36,5	0.61	0.590	700	700	86222,823	86222,823	0.569	86223,392	86223,392
52,0	3 9 12	9 21	9 16,5	0.57								
52,12	Mean.										86223,138	86223,237
2,12	Diff. to 50°.							Correction for Temp. 2°.12.			+ 0,897	+ 0,897
								Vibra. in 24 h. at Temp. 50°.			86224,035	86224,134

Observation of Coincidences at Port Bowen (1st Series)—continued.

Night, 19th June 1825, Port Bowen. Clock gaining at a mean rate 69ˢ.88. Hygʳ. {Temp. 52°.5. Dew Pᵗ. 42°. Barʳ {Begᵍ. 29.759 mer. 47°. Endᵍ. 29.750 — 46°.8. } = 29.819 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
52,5	9 32 16	32 19	32 17,5	1.16	1.120	695	695,5	86221,046	86221,225	2.051	86223,097	86223,276
	43 51	43 55	43 53	1.08	1.040	694	695	86220,687	86221,046	1.768	86222,455	86222,814
	55 25	55 31	55 28	1.00	0.970	696	696,5	86221,403	86221,582	1.538	86222,941	86223,120
52,0	10 7 1	7 8	7 4,5	0 94	0.910	697	697	86221,760	86221,760	1.354	86223,114	86223,114
	18 38	18 45	18 41,5	0 88	0.850	697	697,5	86221,760	86221,938	1.178	86222,938	86223,116
	30 15	30 23	30 19	0.82	0.790	697	698	86221,760	86222,116	1.020	86222,780	86223,136
52,0	41 52	42 2	41 57	0.76	0.735	698	698,5	86222,116	86222,293	0.883	86222,999	86223,176
	53 30	53 41	53 35,5	0.71	0.685	699	698,5	86222,470	86222,293	0.766	86223,236	86223,059
	11 5 9	5 19	5 14	0.66	0.640	699	699,5	86222,470	86222,647	0.670	86223,140	86223,317
51,8	16 48	16 59	16 53,5	0.62								
52,07	Mean.										86222,967	86223,125
2,07	Diff. to 50°.							Correction for Temp. 2°.07.			+ 0,875	+ 0,875
								Vibra. in 24 h. at Temp. 50°.			86223,842	86224,000

Morning, 20th June 1825, Port Bowen. Clock gaining at a mean rate 69ˢ.88. Hygʳ. {Temp. 52°. Dew Pᵗ. 42°. Barʳ. {Begᵍ. 29.749 mer. 46°. Endᵍ. 29.743 — 46°. } = 29.813 mean cor. to temp. of pend.

52,5	0 55 4	55 9	55 6,5	1.12	1.080	696	696	86221,403	86221,403	1.907	86223,310	86223,310
	1 6 40	6 45	6 42,5	1.04	0 995	696	696,5	86221,403	86221,582	1.618	86223,021	86223,200
	18 16	18 22	18 19	0.95	0.915	696	697	86221,403	86221,760	1.369	86222,772	86223,129
51,8	29 52	30 00	29 56	0.88	0.855	697	697	86221,760	86221,760	1.193	86222,953	86222,953
	41 29	41 37	41 33	0.83	0.805	697	697	86221,760	86221,760	1.059	86222,819	86222,819
	53 6	53 14	53 10	0.78	0.755	699	699	86222,470	86222,470	0.932	86223,402	86223,402
51,6	2 4 45	4 53	4 49	0.73	0.705	698	698,5	86222,116	86222,293	0.812	86222,928	86223,105
	16 23	16 32	16 27,5	0.68	0.655	697	700,5	86221,760	86223,000	0.701	86222,461	86223,701
	28 00	28 16	28 8	0.63	0.610	699	699,5	86222,470	86222,647	0.608	86223,078	86223,255
51,2	39 39	39 56	39 47,5	0.59								
51,77	Mean.										86222,972	86223,208
1.77	Diff. to 50°.							Correction for Temp. 1°.77.			+ 0,748	+ 0,748
								Vibra. in 24 h. at Temp. 50°.			86223,720	86223,956

Observation of Coincidences at Port Bowen (1st Series)— continued.

Forenoon, 20th June, 1825, Port Bowen. Clock gaining at a mean rate 69s.88. Hygr. { Temp. 50°.5. Dew Pt. 41°. } Barr. { Begg. 29.746 mer. 46°. Endg. 29.750 — 47°. } = 29°.813 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibra. in 24 h. by Disappearance.	Observed vibra. in 24 h. by Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
51	9 27 45	27 48	27 46,5	1.17								
	39 20	39 25	39 22,5	1.08	1.125	695	696	86221,046	86221,403	2.069	86223,115	86223,472
	50 58	51 3	51 0,5	1.00	1.040	698	698	86222,116	86222,116	1.768	86223,884	86223,884
50,8	10 2 36	2 42	2 39	0.93	0.965	698	698,5	86222,116	86222,293	1.522	86223,638	86223,815
	14 14	14 21	14 17,5	0.86	0.895	698	698,5	86222,116	86222,293	1.309	86223,425	86223,602
	25 53	26 1	26 57	0.81	0.835	699	699,5	86222,470	86222,647	1.138	86223,608	86223,785
50,3	37 33	37 41	37 37	0.76	0.785	700	700	86222,823	86222,823	1.007	86223,830	86223,830
	49 14	49 21	49 17,5	0.70	0.730	701	700,5	86223,176	86223,000	0.871	86224,047	86223,871
	11 00 52	1 2	00 57	0.65	0.675	698	699,5	86222,116	86222,647	0.745	86222,861	86223,392
51,2	12 33	12 41	12 37	0.61	0.630	701	700	86223,176	86222,823	0.649	86223,825	86223,472
50,82	Mean.										86223,581	86223,680
0,82	Diff. to 50°.							Correction for Temp. 0°.82.			+ 0,347	+ 0,347
								Vibra. in 24 h. at Temp. 50°.			86223,928	86224,027

Afternoon, 20th June, 1825, Port Bowen. Clock gaining at a mean rate 69s.88. Hygr. { Temp. 51°. Dew Pt. 36°. } Barr. { Begg. 29.760 mer. 47°. Endg. 29.752 — 47°. } = 29.819 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibra. in 24 h. by Disappearance.	Observed vibra. in 24 h. by Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
50,8	1 32 54	32 57	32 55,5	1.15								
	43 31	43 35	43 33	1.06	1.105	697	697,5	86221,760	86221,938	1.996	86223,756	86223,934
	55 8	55 13	55 10,5	0.98	1.020	697	697,5	86221,760	86221,938	1.701	86223,461	86223,639
50,2	2 6 46	6 51	6 48,5	0.92	0.950	698	698	86222,116	86222,116	1.476	86223,592	86223,592
	18 24	18 32	18 28	0.87	0.895	698	699,5	86222,116	86222,647	1.309	86223,425	86223,956
	30 3	30 11	30 7	0.81	0.840	699	699	86222,470	86222,470	1.154	86223,624	86223,624
50,1	41 42	41 51	41 46,5	0.75	0.780	699	699,5	86222,470	86222,647	0.995	86223,465	86223,642
	53 22	53 31	53 26,5	0.70	0.725	700	700	86222,823	86222,823	0.859	86223,682	86223,682
	3 5 4	5 13	5 8,5	0.66	0.680	702	702	86223,527	86223,527	0.756	86224,283	86224,283
50,1	16 44	16 52	16 48	0.61	0.635	700	699,5	86222,823	86222,647	0.659	86223,482	86223,306
50,3	Mean.										86223,641	86223,740
0,3	Diff. to 50°.							Correction for Temp. 0°.3.			+ 0,127	+ 0,127
								Vibra. in 24 h. at Temp. 50°.			86223,768	86223,867

Observation of Coincidences at Port Bowen (1st Series)—continued.

Night, 20th June, 1825, Port Bowen.
Clock gaining 69s.88 at a mean rate.

Hygr. { Temp. 50°. Dew Pt. 35°. } Bar. { Begg. 29.753 mer. 45° Endg. 29.750 — 48° } = 29.820 mean cor. to temp. of pend.

Temp.	Time of Disappearance	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Vibrat. in 24 h. cor. for Arc. Disappearance.	Vibrat. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
49,5	9 48 50	48 54	48 52	1.15	1.115	696	697	86221,403	86221,760	2.032	86223,435	86223,792
50,0	10 00 26	00 32	00 29	1.08	1.040	695	696	86221,046	86221,403	1.768	86222,814	86223,171
51,5	12 1	12 9	12 5	1.00	0.965	694	694	86220,687	86220,687	1.522	86222,209	86222,209
55,0	23 35	23 43	23 39	0.93	0.900	694	693,5	86220,687	86220,508	1.324	86222,011	86221,832
55,5	35 9	35 16	35 12,5	0.87	0.840	692	693	86219,967	86220,328	1.154	86221,121	86221,482
57,8	46 41	46 50	46 45,5	0.81	0.780	692	691,5	86219,967	86219,786	0,995	86220,962	86220,781
57,0	58 13	58 21	58 17	0.75	0.725	692	692,5	86219,967	86220,148	0.859	86220,826	86221,007
56,0	11 9 45	9 54	9 49,5	0.70	0.675	694	695	86220,687	86221,046	0.745	86221,432	86221,791
56,0	21 19	21 30	21 24,5	0.65	0.630	694	694	86220,687	86220,687	0.649	86221,336	86221,336
54,35	Mean.										86221,794	86221,933
4,35	Diff. to 50°.							Correction for Temp. 4°.35.			+ 1,840	+ 1,840
								Vibra. in 24 h. at Temp. 50°.			86223,634	86223,773

Forenoon, 21st June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.

Hygr. { Temp, 49°.5. Dew Pt. 36° } Barr. { Begg. 29.700 mer. 47°. Endg. 29.709 — 47°. } = 29,766 mean cor. to temp. of pend.

49,8	9 34 13	34 19	34 16	1.12	1.080	700	699,5	86222,823	86222,647	1.907	86224,730	86224,554
48,5	45 53	45 58	45 55,5	1.04	1.005	698	699	86222,116	86222,470	1.650	86223,766	86224.120
49,0	57 31	57 38	57 34,5	0.97	0.940	700	699,5	86222,823	86222,647	1.445	86224,268	86224,092
49,5	10 9 11	9 17	9 14	0.91	0.880	699	699	86222,470	86222,470	1.266	86223,736	86223,736
50,8	20 50	20 56	20 53	0.85	0.820	698	698,5	86222,116	86222,293	1.099	86223,215	86223,392
50,8	32 28	32 35	32 31,5	0.79	0.760	699	699,5	86222,470	86222,647	0.944	86223,414	86223,691
50,8	44 7	44 15	44 11	0.73	0.705	700	700,5	86222,823	86223,000	0.812	86223,635	86223,812
50,6	55 47	55 56	15 51,5	0.68	0.660	700	700	86222,823	86222,823	0 712	86223,535	86223,535
50,5	11 7 27	7 36	7 31,5	0.64	0.620	700	700	86222,823	86222,823	0.628	86223,451	86223,451
50,3	19 7	19 16	19 11,5	0.60								
50,06	Mean.										86223,750	86223,820
0,06	Diff. to 50°.							Correction for Temp, 0°.06.			+ 0,025	+ 0,025
								Vibra. in 24 h. at Temp. 50°.			86223,775	86223,845

Observation of Coincidences at Port Bowen (1st Series)—continued.

Afternoon, 21st June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.

Hygr. { Temp. 50°. / Dew Pt. 36°. } Barr. { Begg. 29.709 mer. 46°. / Endg. 29.700 — 45°. } = 29,767 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
51	1 31 23	31 27	31 25	1.15	1.110	691	691,5	86219,606	86219,786	2.014	86221,620	86221,800
	42 54	42 59	42 56,5	1.07	1.030	699	698,5	86222,470	86222,293	1.735	86224,205	86224,028
	54 33	54 37	54 35	0.99	0.945	704	704,5	86224,227	86224,402	1.460	86225,687	86225,862
49,5	2 6 17	6 22	6 19,5	0.90	0.870	698	699	86222,116	86222,470	1.237	86223,353	86223,707
	17 55	18 2	17 58,5	0.84	0.815	700	700	86222,823	86222,823	1.086	86223,909	86223,909
	29 35	29 42	29 38,5	0.79	0.760	700	700,5	86222,823	86223,000	0.944	86223,767	86223,944
49,5	41 15	41 23	41 19	0.73	0.705	700	700,5	86222,823	86223,000	0.812	86223,635	86223,812
	52 55	53 4	52 59,5	0.68	0.655	701	701,5	86223,176	86223,352	0.701	86223,877	86224,053
	3 4 36	4 46	4 41	0.63	0.610	701	701,5	86223,176	86223,352	0.608	86223,784	86223,960
49,0	16 17	16 28	16 22,5	0.59								
49,75	Mean.										86223,759	86223,897
0,25	Diff. to 50°.							Correction for Temp. 0°.25.			— 0,106	— 0,106
								Vibra. in 24 h. at Temp. 50°.			86223,653	86223,791

Night, 21st June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.

Hygr. { Temp. 52°. / Dew Pt. 36°. } Barr. { Begg. 29.678 mer. 45°. / Endg. 29.671 — 46°. } = 29.739 mean cor. to temp. of pend.

53,5	9 17 54	17 58	17 56	1.15	1.110	693	693,5	86220,328	86220,508	2.014	86222,342	86222,522
53,2	29 27	29 32	29 29,5	1.07	1.030	696	697	86221,403	86221,760	1.735	86223,138	86223,495
53,0	41 3	41 10	41 6,5	0.99	0.955	695	695,5	86221,046	86221,225	1.491	86222,537	86222,716
52,5	52 38	52 46	52 42	0.92	0.890	697	697	86221,760	86221,760	1.295	86223,055	86223,055
52,0	10 4 15	4 23	4 19	0.86	0.830	698	698,5	86222,116	86222,293	1.122	86223,238	86223,415
50,0	15 53	16 2	15 57,5	0.80	0.770	700	699,5	86222,823	86222,647	0.969	86223,792	86223,616
49,5	27 33	27 41	27 37	0.74	0.710	698	699,5	86222,116	86222,647	0.824	86222,940	86223,471
51,5	39 11	39 22	39 16,5	0.68	0.655	699	699,5	86222,470	86222,647	0.701	86223,171	86223,348
52,0	50 50	51 2	50 56	0.63	0.610	698	700	86222,116	86222,823	0.608	86222,724	86223,431
53,0	11 2 28	2 42	2 36	0.59								
52,02	Mean.										86222,993	86223,230
2,02	Diff. to 50°.							Correction for Temp. 2°.02.			+ 0,854	+ 0,854
								Vibra. in 24 h. at Temp. 50°.			86223,847	86224,084

Observation of Coincidences at Port Bowen (1st Series)—continued.

Morning, 22d June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.
Hygr. { Temp. 50°. Dew Pt. 36°. } Barr. { Begg. 29.672 mer. 45°.5. Endg. 29.671 — 46°. } = 29.735 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
50	0 49 43	49 48	49 45,5	1.12	1.080	697	697,5	86221,760	86221,938	1.907	86223,667	86223,845
	1 1 20	1 26	1 23	1.04	1.005	698	699	86222,116	86222,470	1.650	86223,766	86224,120
	12 58	13 6	13 2	0.97	0.935	696	697	86221,403	86221,760	1.429	86222,832	86223,189
50,5	24 34	24 44	24 39	0.90	0.870	699	699,5	86222,470	86222,647	1.237	86223,707	86223,884
	36 13	36 24	36 18,5	0.84	0.810	700	700	86222,823	86222,823	1.073	86223,896	86223,896
	47 53	48 4	47 58,5	0.78	0.755	698	699	86222,116	86222,470	0 932	86223,048	86223,402
50,8	59 31	55 44	59 37,5	0.73	0.705	702	701	86223,527	86223,176	0.812	86224,339	86223,988
	2 11 13	11 24	11 18,5	0.68	0.660	698	698,5	86222,116	86222,293	0.712	86222,828	86223,005
50,0	22 51	23 3	22 57	0.64	0.620	699	699,5	86222,470	86222,647	0.628	86223,098	86223,275
51,5	34 30	34 43	34 36,5	0.60								
50,56	Mean.										86223,465	86223,623
0,56	Diff. to 50°.							Correction for Temp. 0°.56.			+ 0,237	+ 0,237
								Vibra. in 24 h. at Temp. 50°.			86223,702	86223,860

Forenoon, 22d June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.
Hygr. { Temp. 50°. Dew Pt, 42°. } Barr. { Begg. 29.700 mer. 45°. Endg. 29.693 — 44°. } = 29.759 mean cor. to temp. of pend.

50,2	9 31 13	31 18	31 15,5	1.10	1 060	699	698,5	86222,470	86222,293	1.837	86224,307	86224,130
	42 52	42 56	42 54	1.02	0.985	695	696,5	86221,046	86221,582	1.586	86222,632	86223,168
	54 27	54 34	54 30,5	0.95	0.920	700	700	86222,823	88223,823	1.384	86224,207	86224,207
48,5	10 6 7	6 14	6 10,5	0.89	0.860	701	701	86223,176	86223,176	1.209	86224,385	86224,385
	17 48	17 55	17 51,5	0.83	0.800	701	701	86223,176	86223,176	1.046	86224,222	86224,222
	29 29	29 36	29 32,5	0.77	0.745	695	695	86221,046	86221,046	0.907	86221,953	86221,953
48,2	41 4	41 11	41 7,5	0.72	0.695	707	708	86225,269	86225,615	0.788	86226,057	86226,403
	52 51	53 00	52 55,5	0 67	0.645	701	702	86223,176	86223,527	0.680	86223,856	86224,207
	11 4 32	4 43	4 37,5	0.62	0.600	701	700,5	86223,176	86223,000	0.589	86223,765	86223,589
48,2	16 13	16 23	16 18	0.58								
48,77	Mean.										86223,931	86224,029
1,23	Diff. to 50°.							Correction for Temp. 1°.23.			—0,519	—0,519
								Vibra. in 24 h. at Temp. 50°.			86223,412	86223,510

Observation of Coincidences at Port Bowen (1st Series)—continued.

Afternoon, 22nd June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.
Hygr. {Temp. 49°.5. Dew Pt. 38°.} Barr. {Begs. 29.693 mer. 46°. Ends. 29.693 — 44°.5.} = 29.755 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
49,8	1 10 51	10 54	10 52,5	1.18	1.140	697	698,5	86221,760	86222,293	2.125	86223,885	86224,418
	22 28	22 34	22 31	1.10	1.060	698	697,5	86222,116	86221,938	1.837	86223,953	86223,775
	34 6	34 11	34 8,5	1.02	0.990	700	700,5	86222,823	86223,000	1.602	86224,425	86224,602
48,6	45 46	45 52	45 49	0.96	0.930	699	699,5	86222,470	86222,647	1.414	86223,884	86224,061
	57 25	57 32	57 28,5	0.90	0.865	701	701,5	86223,176	86223,352	1.223	86224,399	86224,575
	2 9 6	9 14	9 10	0.83	0.800	701	700,5	86223,176	86223,000	1.046	86224,222	86224,046
48,2	20 47	20 54	20 50,5	0.77	0.745	700	702	86222,823	86223,527	0.907	86223,730	86224,434
	32 27	32 38	32 32,5	0.72	0.690	703	702,5	86223,878	86223,703	0.776	86224,654	86224,479
	44 10	44 20	44 15	0.66	0.640	702	703	86223,527	86223,878	0.670	86224,197	86224,548
48,27	Mean.										86224,150	86224,326
1,73	Diff. to 50°.							Correction for Temp. 1°.73.			—0,732	—0,732
								Vibra. in 24 h. at Temp. 50°.			86223,418	86223,594

Night, 22nd June, 1825, Port Bowen.
Clock gaining at a mean rate 69s.88.
Hygr. {Temp. 49°. Dew Pt. 38°.} Barr. {Begs. 29.692 mer. 45°. Ends. 29.691 — 45°.5.} = 29.755 mean cor. to temp. of pend.

49	9 6 9	6 12	6 10,5	1.18								
	17 47	17 51	17 49	1.09	1.135	698	698,5	86222,116	86222,293	2.106	86224,222	86224,399
	29 25	29 32	29 28,5	1.00	1.045	698	699,5	86222,116	86222,647	1.785	86223,901	86224,432
49,2	41 5	41 12	41 8,5	0.93	0.965	700	700	86222,823	86222,823	1.522	86224,345	86224,345
	52 44	52 52	52 48	0.86	0.895	699	699,5	86222,470	86222,647	1.309	86223,779	86223,956
	10 4 24	4 31	4 27,5	0.81	0.835	700	699,5	86222,823	86222,647	1.138	86223,961	86223,785
50,2	16 2	16 9	16 5,5	0.75	0.780	698	698	86222,116	86222,116	0.995	86223,111	86223,111
	27 41	27 52	27 46,5	0.70	0.725	699	701	86222,470	86223,176	0.859	88223,329	86224,035
	39 22	39 33	39 27,5	0.65	0.675	701	701	86223,176	86223,176	0.745	86223,921	86223,921
50	51 2	51 15	51 8,5	0.61	0.630	700	701	86222,823	86223,176	0.649	86223,472	86223,825
49,6	Mean.										86223,782	86223,979
0,4	Diff. to 50°.							Correction for Temp. 0°.4.			—0,169	—0,169
								Vibra. in 24 h. at Temp. 50°.			86223,613	86223,810

Observation of Coincidences at Port Bowen (1st Series)—continued.

Morning, June 23rd, 1825, Port Bowen.
Clock gaining at a mean rate 69ˢ.88.

Hygʳ. { Temp. 49°. / Dew Pᵗ. 38°. } Barʳ. { Begᵍ. 29.686 mer. 45° / Endᵍ. 29.686 — 45° } = 29.749 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Reapp.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-app.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-app.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
48,9	1 7 35	7 40	7 37,5	1.15	1.110	698	699	86222,116	86222,470	2.014	86224,130	86224,484
46,0	19 13	19 20	19 16,5	1.07	1.030	700	700	86222,823	86222,823	1.735	86224,558	86224,558
46,0	30 53	31 00	30 56,5	0.99	0.965	703	702,5	86223,878	86223,703	1.522	86225,400	86225,225
48,2	42 36	42 42	42 39	0.94	0.910	699	699,5	86222,470	86222,647	1.354	86223,824	86224,001
49,5	54 15	54 22	54 18,5	0.88	0.850	698	699	86222,116	86222,470	1.178	86223,294	86223,648
50,0	2 5 53	6 2	5 57,5	0.82	0.785	700	700	86222,823	86222,823	1.007	86223,830	86223,830
49,8	17 33	17 42	17 37,5	0.75	0.725	699	700,5	86222,470	86223,000	0.859	86223,329	86223‘859
50,0	29 12	29 24	29 18	0.70	0.675	699	698,5	86222,470	86222,293	0.745	86223,215	86223,038
50,0	40 51	41 2	40 56,5	0.65	0.630	700	700,5	86222,823	86223,000	0.649	86223,472	86223,649
50,2	52 31	52 43	52 37	0.61								
48,86	Mean.										86223,895	86224,032
1,14	Diff. to 50°.									Correction for Temp. 1°.14.	—0,482	—0,482
										Vibrations in 24 h. at Temp. 50°.	86223,413	86223,550

Forenoon, 23rd June, 1825, Port Bowen.
Clock gaining at a mean rate 69ˢ.88.

Hygʳ. { Temp. 50°. / Dew Pᵗ. 37°. } Barʳ. { Begᵍ. 29.700 mer. 45° / End. 29.709 — 45°.5 } = 29.767 mean cor. to temp. of pend.

49,5	9 18 41	18 44	18 42,5	1.18	1.135	697	698,5	86221,760	86222,293	2.106	86223,866	86224,399
49,0	30 18	30 24	30 21	1.09	1.050	699	698,5	86222,470	86222,293	1.803	86224,273	86224,096
48,2	41 57	42 2	41 59,5	1.01	0.975	699	700,5	86222,470	86223,000	1.554	86224,024	86224,554
48,5	53 36	53 44	53 40	0.94	0.910	701	700,5	86223,176	86223,000	1.354	86224,530	86224,354
48,8	10 5 17	5 24	5 20,5	0.88	0.850	700	700	86222,823	86222,823	1.178	86224,001	86224,001
49,0	16 57	17 4	17 00,5	0.82	0.790	700	700,5	86222,823	86223,000	1.020	86223,843	86224,020
49,0	28 37	28 45	28 41	0.76	0.735	700	701	86222,823	86223,176	0.883	86223,706	86224,059
48,8	40 17	40 27	40 22	0.71	0.685	702	702,5	86223,527	86223,703	0.766	86224,293	86224,469
48,8	51 59	52 10	52 4,5	0.66	0.640	703	702,5	86223,878	86223,703	0.670	86224,548	86224,373
48,9	11 3 42	3 52	3 47	0.62								
48,85	Mean.										86224,120	86224,258
1,15	Diff. to 50°.									Correction for Temp. 1°.15.	—0,486	—0,486
										Vibrations in 24 h. at Temp. 50°.	86223,634	86223,772

Table I. (*First Series.*)

Time by the Clock of Transits of Stars at Port Bowen, Prince Regent's Inlet, June 1825.

Stars.	14th.	16th.	18th.	19th.	20th.	22d.	23d.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Arcturus	.....	.....	.....	8 8 27,51	8 5 41,67	8 0 9,52	7 57 23,66
Arcturus 2d & 3d wires	.....	8 16 33,03	.....	8 8 13,71	8 5 27,95	7 59 55,92	7 57 9,94
Arcturus 3d wire	8 22 19,38	8 16 46,79	.....	8 8 27,22	8 5 41,46	8 00 9,56	7 57 23,70
Arcturus 3d, 4th, 5th w.	8 22 46,90	.....	.....	8 8 54,91	8 6 8,98	8 00 36,91	7 57 51,05
Arcturus 5th wire	8 23 14,42	.....	8 12 8,93	8 9 22,26	8 6 36,5	8 1 4,35	7 58 18,24
α Lyræ	12 45 9,33	.....	12 34 4,02	12 31 17,73	12 28 31,32	12 22 59,16	12 22 59,16

Table II.

Transits of the Sun.

Time by Clock at the moment of Mean Noon.

15th.	17th.	18th.	19th.	21st.	22d.	23d.
h. m s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
11 47 41,29	11 50 00,78	11 51 10,52	11 52 20,07	11 54 39,86	11 55 49,45	11 56 59,66

From these two Tables, which are formed from the Transit Table, the following rates for the clock, contained in Tables III. and IV. have been computed.

Those in Table III. by dividing the difference between the times of transit of each star, on the successive days as given in Table I. by the interval in days, substracting the quotient from $3^m\ 55^s.91$, the acceleration in one day, and applying a correction to the remainder, for the change in Æ of each star during the interval of their respective successive transits, to obtain the rate in a sidereal day.

Those in Table IV. by comparing the time by the clock at the moment of mean noon of each day, as shown in Table II. with that on each succeeding day, and dividing the difference by the number of days in the interval, by which the rate in a mean solar day for 21 separate intervals has been obtained.

Table III.

Rate of the Clock by the Stars. (Gaining.)

June 1825. Stars.	From 14 to 16	From 14 to 18	From 14 to 19	From 14 to 20	From 14 to 22	From 14 to 23	From 16 to 19	From 16 to 20	From 16 to 22	From 16 to 23	From 18 to 19	From 18 to 20	From 18 to 22	From 18 to 23	From 19 to 20	From 19 to 22	From 19 to 23	From 20 to 22	From 20 to 23	From 22 to 23
	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
Arcturus	——	——	——	——	——	——	——	——	——	——	——	——	——	——	70,08	69,92	69,96	69,85	69,92	70,06
Arcturus 2d & 3d	——	——	——	——	——	——	69,48	69,65	69,74	69,76	——	——	——	——	——	——	——	——	——	——
—— 3d wire .	69,63	——	——	——	——	——	——	——	——	——	——	——	——	——	——	——	——	——	——	——
—— 3, 4, 5 w.	——	——	69,52	69,60	69,67	69,72	——	——	——	——	——	——	——	——	——	——	——	——	——	——
—— 5 wire ..	——	69,55	——	——	——	——	——	——	——	——	69,25	69,71	69,78	69,78	——	——	——	——	——	——
α Lyræ	——	69,57	69,58	69,57	69,63	69,67	——	——	——	——	69,61	69,55	69,69	69,75	69,49	69,38	69,78	69,82	69,88	70,01
Mean	69,63	69,57	69,56	69,58	69,65	69,69	69,48	69,65	69,74	69,76	69,54	69,58	69,71	69,76	69,78	69,65	69,87	69,83	69,90	70,03
Proportion for rate in $3^m\ 56^s$.	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19	+ 0,19
Rate in a mean solar day...	69,82	69,76	69,75	69,77	69,84	69,88	69,67	69,84	69,93	69,95	69,73	69,77	69,90	69,95	69,97	69,84	70,06	70,02	70,09	70,22

Table IV.

Rate of the Clock by the Sun. (Gaining.)

From 15 to 17	From 15 to 18	From 15 to 19	From 15 to 21	From 15 to 22	From 15 to 23	From 17 to 18	From 17 to 19	From 17 to 21	From 17 to 22	From 17 to 23	From 18 to 19	From 18 to 21	From 18 to 22	From 18 to 23	From 19 to 21	From 19 to 22	From 19 to 23	From 21 to 22	From 21 to 23	From 22 to 23
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
69,74	69,74	69,69	69,76	69,74	69,80	69,74	69,64	69,77	69,73	69,81	69,55	69,78	69,73	69,83	69,89	69,79	69,90	69,59	69,90	70,21

Table V. (*1st Series.*)

Vibrations of the Pendulum at Port Bowen, computed at the mean rate of the Clock, viz. 86469,88 vibrations in a mean solar day.

Date.	Time of the Day.	Barometer.	Therm.	Vibrations in 24 h. at temp. 50o.	
				Disappearance.	Mean of Disap. & Re-appearance.
		Inches.	o		
June 14th	Night	29,918	50.83	86223,637	86223,837
15	Morning ...	29,922	48.87	86223,702	86223,840
——	Forenoon...	,906	49.05	86223,886	86224,004
——	Afternoon ..	,857	46.50	86223,612	86223,690
——	Night	,835	46.53	86223,637	86223,812
16	Morning ...	29,836	47.80	86223,430	86223,548
——	Forenoon...	,843	49.28	86224,541	86224,658
——	Afternoon ..	,868	49.98	86223,729	86223,886
——	Night	,859	49.10	86223,556	86223,714
17	Morning ...	29,859	46.00	86223,374	86223,491
——	Forenoon...	,864	50.45	86223,996	86224,114
——	Afternoon ..	,882	52.25	86223,991	86224,130
——	Night	,905	51.62	86223,751	86223,949
18	Morning ...	29,908	51.37	86223,514	86223,713
——	Forenoon...	,946	51.25	86223,980	86224,079
——	Afternoon ..	,965	52.00	86223,998	86224,136
——	Night	,964	51.15	86223,770	86223,869
19	Morning ...	29,956	51.14	86223,595	86223,733
——	Forenoon...	,877	51.87	86223,946	86224,086
——	Afternoon ..	,842	52.12	86224,035	86224,134
——	Night	,819	52.07	86223,842	86224,000
20	Morning ...	29,813	51.77	86223,720	86223,956
——	Forenoon...	,813	50.82	86223,928	86224,027
——	Afternoon ..	,819	50.30	86223,768	86223,867
——	Night	,820	54.35	86223,634	86223,773
21	Forenoon...	29,766	50.06	86223,775	86223,845
——	Afternoon ..	,767	49.75	86223,653	86223,791
——	Night	,739	52.02	86223,847	86224,084
22	Morning ...	29,735	50.56	86223,702	86223,860
——	Forenoon...	,759	48.77	86223,412	86223,510
——	Afternoon ..	,755	48.27	86223,418	86223,594
——	Night	,755	49.60	86223,613	86223,810
23	Morning ...	29,749	48.86	86223,413	86223,550
——	Forenoon...	,767	48.85	86223,634	86223,772
	Mean.	29,844	50.15	86223,736	86223,878

Table VI.

By the Stars.

June, 1825.		Computed vibrations of the pendulum in 24 h. the clock gaining 69s.88 at a mean rate in a mean solar day.		Observed rate of the clock by Stars' Transits.	Corr. to vibrations for diff. of rate and 69s.88.	Correct number of vibrations made by the pendulum in a mean solar day at temp. 50°.		No. of stars observed.	Interval in days.	Factors.
From	To	Disappearance.	Mean of Dis. and Re-app.			Disappearance.	Mean of Dis. and Re-app.			
				s.	vib.					
14th Night	16th Night	86223,748	86223,888	69.82	— 0,06	86223,688	86223,828	0,25	2	0,5
—	18th —	86223,771	86223,910	69.76	— 0,12	86223,651	86223,790	1,25	4	5,0
—	19th —	86223,787	86223,925	69.75	— 0 13	86223,657	86223,795	1,75	5	8,75
—	20th —	86223,783	86223,922	69.77	— 0,11	86223,673	86223,812	1,75	6	10,5
—	22nd —	86223,750	86223,892	69.84	— 0,04	86223,710	86223,852	1,75	8	14,0
—	23rd —	86223,736	86223,878	69.88	—	86223,736	86223,878	1,75	9	15,75
16th Night	19th Night	86223,796	86223,934	69.67	— 0,21	86223,586	86223,724	1,50	3	4,5
—	20th —	86223,788	86223,928	69.84	— 0,04	89223,748	86223,888	1,50	4	6,0
—	22nd —	86223,742	86223,886	69.93	+ 0,05	86223,792	86223,936	1,50	6	9,0
—	23rd —	86223,726	86223,869	69.95	+ 0,07	86223,796	86223,939	1,50	7	10,5
18th Night	19th Night	86223,838	86223,964	69.73	— 0,15	86223,688	86223,814	1,25	1	1,25
—	20th —	86223,804	86223,938	69.77	— 0,11	86223,694	86223,828	1,25	2	2,5
—	22nd —	86223,728	86223,871	69 90	+ 0,02	86223,748	86223,891	1,25	4	5,0
—	23rd —	86223,706	86223,848	69.95	+ 0,07	86223,776	86223,918	1,25	5	6,25
19th Night	20th Night	86223,778	86223,925	69.97	+ 0,09	86223,868	86224,015	2,0	1	2,0
—	22nd —	86223,693	86223,843	69 84	— 0,04	86223,653	86223,803	2,0	3	6,0
—	23rd —	86223,668	86223,817	70.06	+ 0,18	86223,848	86223,997	2,0	4	8,0
20th Night	22nd Night	86223,679	86223,829	70.02	+ 0,14	86223,819	86223,969	2,0	2	4,0
—	23rd —	86223,655	86223,803	70.09	+ 0,21	86223,865	86224,013	2,0	3	6,0
22nd Night	23rd —	86223,553	86223,711	70.22	+ 0,34	86223,893	86224,051	2,0	1	2,0
			Mean.			86223,744	86223,887	Sum of Factors		127,5

Table VII.

By the Sun.										
June 1825.		Computed vibrations of the pendulum in 24 h. the clock gaining 69s.88 at a mean rate in a mean solar day.		Observed rate of the clock by sun's transits.	Corr. for diff. of obsvd. rate and 69s.88.	Correct number of vibrations made by the pendulum in a mean solar day at temp. 50°		No. of stars observed.	Interval of Transits.	Factors.
From	To	Disappear.	Mean of Dis. and Re-app.			Disappear.	Mean of Dis. and Re-app.			
				s.	vib.					
15th Aftn	17th Forn	86223,734	86223,864	69.74	— 0,14	86223,594	86223,724	2	2	4
—	18th	86223,759	86223,899	69.74	— 0,14	86223,619	86223,759	2	3	6
—	19th	86223,776	86223,913	69.69	— 0,19	86223,586	86223,723	2	4	8
—	21st	86223,788	86223,922	69.76	— 0,12	86223,668	86223,802	2	6	12
—	22d	86223,768	86223,906	69.74	— 0,14	86223,628	86223,766	2	7	14
—	23d	86223,736	86223,877	69.80	— 0,08	86223,656	86223,797	2	8	16
17th Aftn	18th Forn	86223,809	86223,968	69.74	— 0,14	86223,669	86223,828	2	1	2
—	19th	86223,818	86223,962	69.64	— 0,24	86223,578	86223,722	2	2	4
—	21st	86223,816	86223,953	69.77	— 0,11	86223,706	86223,843	2	4	8
—	22d	86223,782	86223,923	69.73	— 0,15	86223,632	86223,773	2	5	10
—	23d	86223,736	86223,881	69.81	— 0,07	86223,666	86223,811	2	6	12
18th Aftn	19th Forn	86223,827	86223,956	69.55	— 0,33	86223,497	86223,626	2	1	2
—	21st	86223,819	86223,948	69.78	— 0,10	86223,719	86223,848	2	3	6
—	22d	86223,775	86223,911	69.73	— 0,15	86223,625	86223,761	2	4	8
—	23d	86223,721	86223,863	69.83	— 0,05	86223,671	86223,813	2	5	10
19th Aftn	21st Forn	86223,815	86223,943	69.89	+ 0,01	86223,825	86223,953	2	2	4
—	22d	86223,756	86223,895	69.79	— 0,09	86223,666	86223,805	2	3	6
—	23d	86223,693	86223,838	69.90	+ 0,02	86223,713	86223,858	2	4	8
21st Aftn	22d Forn	86223,653	86223,811	69.59	— 0,29	86223,363	86223,521	2	1	2
—	23d	86223,586	86223,746	69.90	+ 0,02	86223,606	86223,766	2	2	4
22d Aftn	23d Forn	86223,519	86223,681	70.21	+ 0,33	86223,849	86224,011	2	1	2
Mean						86223,645	86223,786	Sum of Factors		148

The number of vibrations made by the pendulum in 24 mean solar hours, as obtained by the disappearance of the white disk, from rates deduced by the transits of stars, is 86223,744, and by the sun 86223,645. And of those resulting from the mean of disappearance and re-appearance by the stars, is 86223,877, and by the sun 86223,786; but the sums of the factors being respectively 127,5, and 148, the

mean number of vibrations in 24 hours is 86223,659 by the observation of disappearance, and 86223,800 by the mean of disappearance and re-appearance.

The mean height of the barometer was 29,844 inches, and the mean temp. 50°.15; whence it appears that the specific gravity of the pendulum was to that of air, as 7000,6 to 1, which gives 6ᵛ.158 as a correction additive for the buoyancy of the atmosphere. The ball of the pendulum was found by levelling to be 121,04 feet above low water (neap tides), the correction for which by the duplicate ratio of distances from the earth's centre (3950,858 miles) is, 0ᵛ.500 in 24 hours. And as the station was the tabular surface of a bed of secondary limestone, I suppose the proper multiplier is $\frac{66}{100}$, which will give 0ᵛ.330 for the correction to be added due to this elevation. These corrections being applied to the number of vibrations before found, will give the number of vibrations that would have been made by the pendulum in a mean solar day, in vacuo at the level of the sea, the temperature being 50° of FAHRENHEIT at Port Bowen, in latitude* 73° 13′ 39″.4 N, longitude 88° 54′ 48″ W, and are as follows:

By the observation of disappearance - 86230,147
By the mean of disappearance and re-appear. 86230,288

The state of the ice in the offing being such, as to indicate no immediate prospect of the ships leaving Port Bowen, I gladly availed myself of Captain PARRY's permission to pursue these observations by another series; the difference between the results of which, and those of the first series, being only 0.105 of a vibration in 24 hours, affords, it is presumed,

* The elements of the observations for the latitude, and longitude, are given in the Appendix to the Narrative of Captain PARRY's Third Voyage for the Discovery of a North-West Passage.

a satisfactory proof, that no material error in the rate of the clock is to be feared, from the limited number of transits of stars, to which I was confined during the experiments.

The following are the observations of the Second Series.

Experiment II.—*Second Series at Port Bowen, July* 1825.

Comparisons of Chronometer No. I. with the Clock.

Date.	Chronometer.	Clock.	Difference.
	h. m. s.	h. m. s.	h. m. s.
Noon 6th.	2 16 23,5	9 17 00	4 59 23,5
— —	2 26 23	9 27 00	4 59 23
P. M. —	9 21 33,5	4 22 30	4 59 3,5
— —	9 32 3	4 33 00	4 59 3
— —	1 37 51,5	8 39 00	4 58 51,5
— —	1 48 51	8 50 00	4 58 51
P. M. 7th.	9 19 56	4 22 00	4 57 56
— —	9 30 55,5	4 33 00	4 57 55,5
— —	1 35 44	8 38 00	4 57 44
— —	1 46 43,5	8 49 00	4 57 43,5
Noon 8th.	2 16 8	9 19 00	4 57 8
— —	2 27 7,5	9 30 00	4 57 7,5
P. M. —	9 11 48,5	4 15 00	4 56 48,5
— —	9 22 48	4 26 00	4 56 48
— —	1 29 36,5	8 33 00	4 56 36,5
— —	1 51 35,5	8 55 00	4 56 35,5
Noon 9th.	2 17 00,5	9 21 00	4 56 0,5
— —	2 28 00	9 32 00	4 56 00
P. M. —	9 4 41,5	4 9 00	4 55 41,5
— —	9 15 41	4 20 00	4 55 41
— —	1 32 29	8 37 00	4 55 29
— —	1 42 28,5	8 47 00	4 55 28,5
Noon 10th.	2 14 53	9 20 00	4 54 53
— —	2 24 52,5	9 30 00	4 54 52,5
P. M. —	8 58 34	4 4 00	4 54 34
— —	9 19 33	4 25 00	4 54 33
— —	1 25 21,5	8 31 00	4 54 21,5
— —	1 35 21	8 41 00	4 54 21

Transits observed at Port Bowen, July 1825—(*2nd Series.*)

Date.	Stars.	1st Wire observed.	1st Wire corrected.	2nd Wire.	3rd Wire.	4th Wire.	5th Wire.	Mean Chron.	Comparison of Chro. with Clock.	Mean Clock.	Clock at mean Noon.
		h. m. s.	h. m. s.	m. s.	h. m. s.	m. s.	m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
July 6th Noon	⊙'s 1st Limb	2 18 4	.....	18 325	2 19 00,5	19 29	19 56,5				
	⊙'s 2nd Limb	2 20 21	.....	20 49,75	2 21 18	21 45,5	22 13,5				
	⊙'s Centre	2 19 12,5	2 19 13,26	19 41,12	2 20 9,25	20 37,25	21 5	2 29 9,19	4 59 23,31	9 20 45,88	9 16 28,54
P. M.	Arcturus	9 23 50,5	9 23 51,24	24 18,5	9 24 46	25 13	25 40,6	9 24 45,89	4 59 3,35	4 25 42,54	
	α Lyræ	1 46 17	1 46 17,9	46 51	1 47 23,5	47 56	48 29	1 47 23,48	4 58 51,07	8 48 32,41	
P. M. 7th	Arcturus	9 19 56,5	9 19 57,24	20 25,5	9 20 52,5	21 20	21 47,5	9 20 52,54	4 57 55,96	4 22 56,58	
	α Lyræ	1 42 23,5	1 42 24,4	42 57,5	1 43 30,5	44 3,5	44 36	1 43 30,4	4 57 43,65	8 45 46,75	
8th Noon	⊙'s 1st Limb	2 18 28	.....	18 57,5	2 19 25	19 52,5	20 20,5				
	⊙'s 2nd Limb	2 20 45,5	.....	21 14	2 21 42	22 10	22 38				
	⊙'s Centre	2 19 36,75	2 19 37,51	20 5,75	2 20 33,5	21 1,25	21 29,25	2 20 33,46	4 57 7,8	9 23 25,66	9 18 48,99
P. M.	Arcturus	9 16 4	9 16 4,74	16 32	9 16 59	17 26,5	17 54	9 16 59,21	4 56 48,26	4 20 10,95	
	α Lyræ	1 38 30	1 38 30,9	39 4,5	1 39 37	40 10	40 42,5	1 39 36,98	4 56 36,05	8 43 0,93	
9th Noon	⊙'s 1st Limb	2 18 40,5	.....	19 9	2 19 37	20 4,7	20 32,5				
	⊙'s 2nd Limb	2 20 56,9	.....	21 25,5	2 21 53,5	22 21	22 49				
	⊙'s Centre	2 19 48,7	2 19 49,46	20 17,25	2 20 45,25	21 12,85	21 40,75	2 20 45,13	4 56 0,33	9 24 44,8	9 19 59,03
P. M. 9th	Arcturus	9 12 10	9 12 10,74	12 38,5	9 13 5,5	13 33	14 00,5	9 13 5,62	4 55 41,08	4 17 24,54	
	α Lyræ	1 34 37	1 34 37,9	35 11	1 35 43,5	36 16,5	36 49,5	1 35 43,65	4 55 28,84	8 40 14,81	
10th Noon	⊙'s 1st Limb	2 18 51,5	.....	19 20,5	2 19 48	20 16	20 43,5				
	⊙'s 2nd Limb	2 21 8,25	.....	21 37,5	2 22 5	22 33	23 1				
	⊙'s Centre	2 19 59,87	2 20 00,63	20 29	2 20 56,5	21 24,5	21 52,25	2 20 56,56	4 54 52,7	9 26 3,86	9 21 9,36
P. M.	Arcturus	9 8 16,5	9 8 17,24	8 45	9 9 12,5	9 39,5	10 7	9 9 12,29	4 54 33,49	4 14 38,8	
	α Lyræ	1 30 43,2	1 30 44,10	31 17	1 31 50	32 23	32 55,5	1 31 49,93	4 54 21,18	8 37 28,75	

Observation of Coincidences at Port Bowen (2nd Series).

P. M. July 6, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88. in 24 h.

Hygr. { Temp. 51°. Dew Pt. 40°. } Barr. { Begs. 29 694 mer. 48°.5. Ends. 29.694 — 48°.5. } = 29.755 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
50,6	10 31 36	31 39	31 37,5	1.18	1.140	694	695	86220,687	86221,046	2.125	86222,812	86223,171
50,9	42 10	42 15	42 12,5	1.10	1.060	696	696	86221,403	86221,403	1.837	86223,240	86223,240
51,0	53 46	53 51	43 48,5	1.02	0.985	696	696	86221,403	86221,403	1.586	86222,989	86222,989
50,9	11 5 22	5 27	5 24,5	0.95	0.920	697	698,5	86221,760	86222,293	1.384	86223,144	86223,677
50,5	16 59	17 7	17 3	0.89	0.855	697	697,5	86221,760	86221,938	1.193	86222,953	86223,131
50,3	28 36	28 45	28 40,5	0.82	0.795	698	698	86222,116	86222,116	1.033	86223,149	86223,149
50,1	40 14	40 23	40 18,5	0.77	0.745	700	700	86222,823	86222,823	0.907	86223,730	86223,730
50,1	51 54	52 3	51 58,5	0.72	0.690	698	699	86222,116	86222,470	0 776	86222,892	86223,246
50,5	12 3 32	3 43	3 37,5	0.66	0 640	699	699	86222,470	86222,470	0.670	86223,140	86223,140
50,59	Mean.										86223,117	86223,275
0,59	Diff. to 50°.								Correction for Temp. 0°.59.		+ 0,249	+ 0,249
									Vib. in 24 h. at Temp. 50°.		86223,366	86223,524

P. M. July 6, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88. in 24 h.

Hygr. { Temp. 50°.5. Dew Pt. 40°.0. } Barr. { Begs. 29,694 mer. 48°.5. Ends. 29,760 — 49°. } = 29.757 mean cor. to temp. of pend.

51,0	12 32 4	32 7	32 5,5	1.17	1.130	695	696	86221,046	86221,403	2.088	86223,134	86223,491
50,6	43 39	43 44	43 41,5	1.09	1.050	697	697	86221,760	86221,760	1.803	86223,563	86223,563
50,5	55 16	55 21	55 18,5	1.01	0.975	696	697	86221,403	86221,760	1.554	86222,957	86223,314
50,3	1 6 52	6 59	6 55,5	0.94	0.920	698	698,5	86222,116	86222,293	1.384	86223,500	86223,677
50,3	18 30	18 38	18 34	0.88	0.850	698	697,5	86222,116	86221,938	1.178	86223,294	86223,116
50,8	30 8	30 15	30 11,5	0.82	0.790	696	697	86221,403	86221,760	1.020	86222,423	86222,780
51,2	41 44	41 53	41 48,5	0.76	0.730	699	699,5	86222,470	86222,647	0.871	86223,341	86223,518
51,0	53 23	53 33	43 28	0.70	0.675	698	698	86222,116	86222,116	0.745	86222,861	86222,861
50,9	2 5 1	5 11	5 6	0.65	0.630	699	699,5	86222,470	86222,647	0.649	86223,119	86223,296
50,8	16 40	16 51	16 45,5	0.61								
50,74	Mean.										86223,132	86223,291
0,74	Diff. to 50°.								Correction for Temp. 0°.74.		+ 0,313	+ 0,313
									Vibra. in 24 h. at Temp. 50°.		86223,445	86223,604

Observation of Coincidences at Port Bowen (2nd Series)—continued.

A.M. July 7, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h.

Hygr. { Temp. 53°. Dew Pt. 44°. } Barr. { Begg. 29.684 mer. 49°. Endg. 29.690 — 51°. } = 29.749 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
52,8	4 7 26	7 29	7 27,5	1.16	1.120	693	694	86220,328	86220,687	2.051	86222,379	86222,738
52,2	18 59	19 4	19 1,5	1.08	1.040	694	694,5	86220,687	86220,867	1.768	86222,455	86222,635
52,9	30 33	30 39	30 36	1.00	0.965	694	694	86220,687	86220,687	1.523	86222,210	86222,210
53,9	42 7	42 13	43 10	0.93	0.900	695	695,5	86221,046	86221,225	1.324	86222,370	86222,549
53.5	53 42	53 49	53 45,5	0.87	0.845	694	694,5	86220,687	86220,867	1.166	86221,853	86222,033
53,2	5 5 16	5 24	5 20	0.82	0.795	696	696,5	86221,403	86221,582	1.033	86222,436	86222,615
53,0	16 52	17 1	17 56,5	0.77	0.745	697	696	86221,760	86221,403	0.907	86222,667	86222,310
52,0	28 29	28 36	28 32,5	0 72	0.695	694	696,5	86220,687	86221,582	0.788	86221,475	86222,370
52,2	40 3	40 15	40 9	0.67	0.645	697	697	86221,760	86221,760	0.680	86222,440	86222,440
52,6	51 40	51 52	51 46	0.62								
52,83	Mean.										86222,254	86222,433
2,83	Diff. to 50°.							Correction for Temp. 2°.83.			+ 1,197	+ 1,197
								Vibrations in 24 h. at Temp. 50°.			86223,451	86223,630

A.M. July 7, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h.

Hygr. { Temp. 54°. Dew Pt. 43°. } Barr. { Begg. 29.682 mer. 51°. Endg. 29.681 — 51°.2. } = 29.742 mean cor. to temp. of pend.

53,8	6 32 28	32 31	32 29,5	1.18	1.140	692	693	86219,967	86220,328	2.125	86222,092	86222,453
53,5	44 00	45 5	44 2,5	1.10	1.060	692	692	86219,967	86219,967	1.837	86221,804	86221,804
53,5	55 32	55 37	55 34,5	1.02	0.985	694	694,5	86220,687	86220,867	1.586	86222,273	86222,453
54,0	7 7 6	7 12	7 9	0.95	0.915	693	694	86220,328	86220,687	1.369	86221,697	86222,056
54,0	18 39	18 47	18 43	0.88	0.850	694	694,5	86220,687	86220,867	1.178	86221,865	86222,045
54,0	30 13	30 22	30 17,5	0.82	0.795	695	695	86221,046	86221,046	1.033	86222,079	86222,079
54,0	41 48	41 57	41 52,5	0.77	0.745	694	694	86220,687	86220,687	0.907	86221,594	86221,594
54,0	53 22	53 31	53 26,5	0.72	0.695	696	696	86221,403	86221,403	0.788	86222,191	86222,191
53,6	8 4 58	5 7	5 2,5	0.67	0.650	695	695,5	86221,046	86221,225	0.691	86221,737	86221,916
53,1	16 33	16 43	16 38	0.63								
53,75	Mean.										86221,926	86222,066
3,75	Diff. to 50°.							Correction for Temp. 3°.75.			+ 1,586	+ 1,586
								Vibra. in 24 h. at Temp. 50°.			86223,512	86223,652

Observation of Coincidences at Port Bowen (2nd Series)—continued.

P. M. July 7, 1825, Port Bowen. Clock gaining at an assumed rate 69ˢ.88 in 24 h.

Hygʳ. { Temp. 53°. Dew Ptᵗ. 43°.

Barʳ. { Begᵍ. 29.683 mer. 51°.5. Endᵍ. 29.692 — 51°. } = 29.746 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
52,8	10 28 44	28 47	28 45,5	1.16	1.120	693	693,5	86220,328	86220,508	2.051	86222,379	86222,559
52,6	40 17	40 21	40 19	1.08	1.045	694	694,5	86220,687	86220,867	1.785	86222,472	86222,652
52,7	51 51	51 56	51 53,5	1.01	0.975	695	695	86221,046	86221,046	1.554	86222,600	86222,600
52,2	11 3 26	3 31	3 28,5	0.94	0.905	694	695	86220,687	86221,046	1.339	86222,026	86222,385
52,0	15 00	15 7	15 3,5	0.87	0.845	696	696	86221,403	86221,403	1.166	86222,569	86222,569
52,5	26 36	26 43	26 39,5	0.82	0.790	696	697	86221,403	86221,760	1.020	86222,423	86222,780
53,0	38 12	38 21	38 16,5	0.76	0.735	697	696,5	86221,760	86221,582	0.883	86222,643	86222,465
53,0	49 49	49 57	49 53	0.71	0.680	695	695,5	86221,046	86221,225	0.756	86221,802	86221,981
53,1	12 1 4	1 33	1 28,5	0.65	0.635	696	697	86221,403	86221,760	0.659	86222,062	86222,419
53,1	13 00	13 11	13 5,5	0.62								
52,7	Mean.										86222,331	86222,490
2,7	Diff. to 50°.								Correction for Temp. 27°.		+ 1,142	+ 1,142
									Vibrations in 24 h. at Temp. 50°.		86223,473	86223,632

P. M. July 7, 1825, Port Bowen. Clock gaining at an assumed rate 69ˢ.88 in 24 h.

Hygʳ. { Temp. 53°. Dew Ptᵗ. 43°.

Barʳ. { Begᵍ. 29.692 mer. 51°. Endᵍ. 29.700 — 51°.2. } = 29.756 mean cor. to temp. of pend.

52,8	1 6 40	6 44	6 42	1.16	1.120	694	694,5	86220,687	86220,867	2.051	86222,738	86222,918
52,5	18 14	18 19	18 16,5	1.08	1.040	693	693,5	86220,328	86220,508	1.768	86222,096	86222,276
53,0	29 47	29 53	29 50	1.00	0.970	694	694	86220,687	86220,687	1.538	86222,225	86222,225
53,5	41 21	41 27	41 24	0.94	0.900	695	695,5	86221,046	86221,225	1.324	86222,370	86222,549
52,8	52 56	53 3	52 59,5	0.86	0.830	696	696	86221,403	86221,403	1,122	86222,525	86222,525
52,7	2 4 32	4 39	4 35,5	0.80	0.775	695	695,5	86221,046	86221,225	0.982	86222,028	86222,207
52,6	16 7	16 15	16 11	0.75	0.725	694	695	86220,687	86221,046	0.859	86221,546	86221,905
53,7	27 41	27 51	27 46	0.70	0.675	695	695,5	86221,046	86221,225	0.745	86221,791	86221,970
53,8	39 16	39 27	39 21,5	0.65	0.630	696	696	86221,403	86221,403	0.649	86222,052	86222,052
53,5	50 52	51 3	50 57,5	0.61								
53,09	Mean.										86222,152	86222,292
3,09	Diff. to 50°.								Correction for Temp. 3°.09.		+ 1,307	+ 1,307
									Vibra. in 24 h. at Temp. 50°.		86223,459	86223,599

Observation of Coincidences at Port Bowen (2nd Series)—continued.

A. M. July 8, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h.

Hygr. { Temp. 50°. Dew Pt. 40°.

Bar. { Begs. 29.749 mer. 48°. Ends. 29.747 — 48°.2. } = 29,810 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Interval in seconds of Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Observed vibra. cor. for Arc. Disappearance.	Observed vibra. cor. for Arc. Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
49,8	4 12 42	12 47	12 44,5	1.16	1.120	696	696	86221,403	86220,403	2.051	86223,454	86223,454
49,9	24 18	24 23	24 20,5	1.08	1.045	696	696,5	86221,403	86221,582	1.786	86223,189	86223,368
50,5	35 54	36 00	35 57	1.01	0.975	696	696,5	86221,403	86221,582	1.554	86222,957	86223,136
50,8	47 30	47 37	47 33,5	0.94	0.905	696	696,5	86221,403	86221,582	1.339	86222,742	86222,921
50,5	59 6	59 14	59 10	0.87	0.840	698	698,5	86222,116	86222,293	1.154	86223,270	86223,447
50,3	5 10 44	10 53	10 48,5	0.81	0.780	698	698	86222,116	86222,116	0.995	86223,111	86223,111
50,0	22 22	22 31	22 26,5	0.75	0.730	699	700,5	86222,470	86223,000	0.871	86223,341	86223,871
49,9	34 1	34 13	34 7	0.71	0.685	699	698,5	86222,470	86222,293	0.766	86223,236	86223,059
49,8	45 40	45 51	45 45,5	0.66	0.635	700	700	86222,823	86222,823	0.659	86223,482	86223,482
50,0	57 20	57 31	57 25,5	0.61								
50,15	Mean.										86223,198	86223,316
0,15	Diff. to 50°.									Correction for Temp. 0°.15.	+ 0,063	+ 0,063
										Vibra. in 24 h. at Temp. 50°.	86223,261	86223,379

A. M. July 8, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h.

Hygr. { Temp. 50°. Dew Pt. 40°.

Bar. { Begs. 29.750 mer. 48°.2. Ends. 29.751 — 48°. } = 29.810 mean cor. to temp. of pend.

49,9	6 49 8	49 11	49 9,5	1.16	1.120	696	697	86221,403	86221,760	2.051	86223,454	86223,811
49,5	7 00 44	00 49	00 46,5	1.08	1.045	696	697	86221,403	86221,760	1.786	86223,189	86223,546
49,2	12 20	12 27	12 23,5	1.01	0.975	699	698	86222,470	86222,116	1.554	86224,024	86223,670
49,1	23 59	24 4	22 1,5	0.94	0.905	698	699,5	86222,116	86222,647	1.339	86223,455	86223,986
49,2	35 37	35 45	35 41	0.87	0.840	699	698,5	86222,470	86222,293	1.154	86223,624	86223,447
49,2	47 16	47 23	47 19,5	0.81	0.780	698	699	86222,116	86222,470	0.995	86223,111	86223,465
49,2	58 54	59 3	54 58,5	0.75	0.730	701	701	86223,176	86223,176	0.871	86224,047	86224,047
49,4	8 10 35	10 44	10 39,5	0.71	0.685	699	699,5	86222,470	86222,647	0.766	86223,236	86223,413
49,4	22 14	22 24	22 19	0.66	0.635	701	701	86223,176	86223,176	0.659	86223,835	86223,835
49,5	33 55	34 5	34 00	0.61								
49,36	Mean.										86223,553	86223,691
0,64	Diff. to 50°.									Correction for Temp. 0°.64.	— 0,271	— 0,271
										Vibra. in 24 h. at Temp. 50°.	86223,282	86223,420

Observation of Coincidences at Port Bowen (2nd Series)—continued.

P.M. July 8, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h.

Hygr. { Temp. 51°. Dew Pt. 40°.

Barr. { Begs. 29.750 mer. 49°.5. Ends. 29.752 — 49°. } = 29.812 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock. Disap.	Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Mean of Disap. Re-ap.	Correct. for Arc.	Observed vibra. cor. for Arc. Disappearance.	Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
51,0	10 22 15	22 19	22 17	1.16	1.120	695	695,5	86221,046	86221,225	2.051	86223,097	86223,276
50,8	33 50	33 55	33 52,5	1.08	1.045	696	697	86221,403	86221,760	1.785	86223,188	86223,545
50,5	45 26	45 33	45 29,5	1.01	0.980	697	697	86221,760	86221,760	1.570	86223,330	86223,330
50,7	57 3	57 10	57 6,5	0.95	0.915	697	698	86221,760	86222,116	1.369	86223,129	86223,485
50,5	11 8 40	8 49	8 44,5	0.88	0.850	698	698	86222,116	86222,116	1.178	86223,294	86223,294
50,3	20 18	20 27	20 22,5	0.82	0.790	700	699,5	86222,823	86222,647	1.020	86223,843	86223,667
50,2	31 58	32 6	32 2	0.76	0.735	699	700	86222,470	86222,823	0.883	86223,353	86223,706
50,0	43 37	43 47	43 42	0.71	0.680	699	699,5	86222,470	86222,647	0.756	86223,226	86223,403
50,0	55 16	55 27	55 21,5	0.65	0.630	698	699,5	86222,116	86222,647	0.649	86222,765	86223,296
49,6	12 6 54	7 8	7 1	0.61								
50,36	Mean.										86223,247	86223,445
0,36									Correction for Temp. o°.36.		+ 0,152	+ 0,152
	Diff. to 50°.								Vibra. in 24 h. at Temp. 50°.		86223,399	86223,597

P.M. July 8, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h.

Hygr. { Temp. 50°. Dew Pt. 38°.5.

Bar. { Begs. 29.752 mer. 49°. Ends. 29.764 — 49°.5. } = 29.819 mean cor. to temp. of pend.

50,5	12 35 36	35 39	35 37,5	1.19	1.150	696	696,5	86221,403	86221,582	2.162	86223,565	86223,744
50,2	47 12	47 16	47 14	1.11	1.070	696	696,5	86221,403	86221,582	1.872	86223,275	86223,454
50,1	58 48	58 53	58 50,5	1.03	0.990	697	698	86221,760	86222,116	1.602	86223,362	86223,718
50,2	1 10 25	10 32	10 28,5	0.95	0.915	697	697	86221,760	86221,760	1.369	86223,129	86223,129
50,7	22 2	22 9	22 5,5	0.88	0.850	698	698,5	86222,116	86222,293	1.178	86223,294	86223,471
50,8	33 40	33 48	33 44	0.82	0.795	698	698,5	86222,116	86222,293	1.033	86223,149	86223,326
50,8	45 18	45 27	45 22,5	0.77	0.745	698	698,5	86222,116	86222,293	0.907	86223,023	86223,200
50,6	56 56	57 6	57 1	0.72	0.695	700	700,5	86222,823	86223,000	0.788	86223,611	86223,788
50,5	2 8 36	8 47	8 41,5	0.67	0.645	700	700	86222,823	86222,823	0.680	86223,503	86223,503
50,5	20 16	20 27	20 21,5	0.62								
50,49	Mean.										86223,323	86223,481
0,49									Correction for Temp. o°.49.		+ 0,207	+ 0,207
	Diff. to 50°.								Vibra. in 24 h. at Temp. 50°.		86223,530	86223,688

Observation of Coincidences at Port Bowen (2nd Series) —continued.

A.M. July 9, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h,

Hygr. { Temp. 52°. Dew P. 44°.

Barr. { Begs. 29.750 mer. 49°. Ends. 29.750 — 51°. } = 29.812 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
51,0	6 44 31	44 35	44 33	1.19	1.145	695	695,5	86221,046	86221,225	2.143	86223,189	86223,368
51,0	56 6	56 11	56 8,5	1.10	1.060	696	696	86221,403	86221,403	1.837	86223,240	86223,240
50,8	7 7 42	7 47	7 44,5	1.02	0.985	696	697	86221,403	86221,760	1.586	86222,989	86223,346
51,0	19 18	19 25	19 21,5	0.95	0.915	698	697,5	86222,116	86221,938	1.369	86223,485	86223,307
51,1	30 56	31 2	30 59	0.88	0.850	697	697,5	86221,760	86221,938	1.178	86222,938	86223,116
51,0	42 33	42 40	42 36,5	0.82	0.790	698	698	86222,116	86222,116	1.020	86223,136	86223,136
51,0	54 11	54 18	54 14,5	0.76	0.740	697	698	86221,760	86222,116	0.895	86222,655	86223,011
51,8	8 5 48	5 57	5 52,5	0.72	0.695	698	698,5	86222,116	86222,293	0.788	86222,904	86223,081
52,3	17 26	17 36	17 31	0.67	0.645	698	697,5	86222,116	86221,938	0.680	86222,796	86222,618
52,7	29 4	29 13	29 8,5	0.62								
51,37	Mean.										86223,037	86223,136
								Correction for Temp. 1°.37.			+ 0,579	+ 0,579
1,37	Diff. to 50°.							Vibra. in 24 h. at Temp. 50°.			86223,616	86223,715

P.M. July 9, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h.

Hygr. { Temp. 53°, Dew Pt. 42°.

Barr. { Begs. 29,751 mer. 51°.5. Ends. 29,749 — 51°.5. } = 29,811 mean cor. to temp. of pend.

53,0	10 30 19	30 21	30 20	1.20	1.160	692	693,5	86219,967	86220,508	2.200	86222,167	86222,708
52,6	41 51	41 56	41 53,5	1.12	1.080	696	695,5	86221,403	86221,225	1.907	86223,310	86223,132
52,7	53 27	53 31	53 29	1.04	1.005	694	695,5	86220,687	86221,225	1.651	86222,338	86222,876
52,6	11 5 1	5 8	5 4,5	0.97	0.935	695	695	86221,046	86221,046	1.429	86222,475	86222,475
52,6	16 36	16 43	16 39,5	0.90	0.870	696	696,5	86221,403	86221,582	1.237	86222,640	86222,819
52,7	28 12	28 20	28 16	0.84	0.815	696	696	86221,403	86221,403	1.086	86222,489	86222,489
52,8	39 48	39 56	39 52	0.79	0.760	697	697	86221,760	86221,760	0.944	86222,704	86222,704
52,8	51 25	51 33	51 29	0.73	0.710	697	697	86221,760	86221,760	0.824	86222,584	86222,584
52,9	12 3 2	3 10	3 6	0.69	0.660	696	697	86221,403	86221,760	0.712	86222,115	86222,472
52,8	14 38	14 48	14 43	0.63								
52,75	Mean.										86222,536	86222,695
								Correction for Temp. 2°.75.			+ 1,163	+ 1,163
2,75	Diff. to 50°.							Vibra. in 24h at Temp. 50°.			86223,699	86223,858

Observation of Coincidences at Port Bowen (2nd Series)—continued.

P. M. July 9, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h.

Hygr. { Temp. 53°. Dew Pt. 42°.

Barr. { Begs. 29.749 mer. 51°.5. Ends. 29.739 — 51°.8. } = 29.804 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds by Clock. Disap.	Interval in seconds by Clock. Disap. & Re-ap.	Observed vibrations in 24 h. Disappearance.	Observed vibrations in 24 h. Mean of Disap. and Re-ap.	Correct. for Arc.	Vibra. in 24 h. cor. for Arc. Disappearance.	Vibra. in 24 h. cor. for Arc. Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
53,0	1 26 10	26 13	26 11,5	1.21	1.170	692	692,5	86219,967	86220,148	2.238	86222,205	86222,386
53,0	37 42	37 46	37 44	1.13	1.090	694	694,5	86220,687	86220,867	1.942	86222,629	86222,809
52,5	49 16	49 21	49 18,5	1.05	1.015	695	696	86221,046	86221,403	1.683	86222,729	86223,086
52,3	2 00 51	00 58	00 54,5	0.98	0.950	695	695	86221,046	86221,046	1.476	86222,522	86222,522
52,3	12 26	12 33	12 29,5	0.92	0.885	696	696	86221,403	86221,403	1.280	86222,683	86222,683
52,7	24 2	24 9	24 5,5	0.85	0.820	695	695,5	86221,046	86221,225	1.099	86222,145	86222,324
53,0	35 37	35 45	35 41	0.79	0.760	696	697	86221,403	86221,760	0.944	86222,347	86222,704
52,9	47 13	47 23	47 18	0.73	0.705	697	697	86221,760	86221,760	0.812	86222,572	86222,572
53,0	58 50	59 00	58 55	0.68	0.655	696	696,5	86221,403	86221,582	0.701	86222,104	86222,283
53,0	3 10 26	10 37	10 31,5	0.63								
52,77	Mean.										86222,437	86222,597
2,77	Diff. to 50°.							Correction for Temp. 2°.77.			+1,172	+1,172
								Vibrations in 24 h. at Temp. 50°.			86223,609	86223,769

A. M. July 10, 1825, Port Bowen. Clock gaining at an assumed rate 69s.88 in 24 h.

Hygr. { Temp. 50°. Dew Pt. 43°.

Barr. { Begs. 29.709 mer. 47°.5. Ends. 29.710 — 48°. } = 29.772 mean cor. to temp. of pend.

49,9	5 5 39	5 42	5 40,5	1.20	1.160	696	697	86221,403	86221,760	2.200	86223,603	86223,960
49,8	17 15	17 20	17 17,5	1.12	1.080	698	698	86222,116	86222,116	1.907	86224,023	86224,023
49,6	28 53	28 58	28 55,5	1.04	1.005	697	697,5	86221,760	86221,938	1.650	86223,410	86223,588
49,7	40 30	40 36	40 33	0.97	0.935	698	699	86222,116	86222,470	1.429	86223,545	86223,899
49,9	52 8	52 16	52 12	0.90	0.865	699	698,5	86222,470	86222,293	1.223	86223,693	86223,516
49,7	6 3 47	3 54	3 50,5	0.83	0.805	699	700	86222,470	86222,823	1.059	86223,529	86223,882
49,5	15 26	15 35	15 30,5	0.78	0.755	701	701,5	86223,176	86223,352	0.932	86224,108	86224,284
50,0	27 7	27 17	27 12	0.73	0.705	699	699	86222,470	86222,470	0.812	86223,282	86223,282
49,9	38 46	38 56	38 51	0.68	0.655	700	700,5	86222,823	86223,000	0.701	86223,524	86223,701
49,4	50 26	50 37	50 31,5	0.63								
49,74	Mean.										86223,635	86223,793
0,26	Diff. to 50°.							Correction for Temp. 0°.26.			— 0,110	— 0,110
								Vibra. in 24 h. at Temp. 50°.			86223,525	86223,683

Observation of Coincidences at Port Bowen (2nd Series)—continued.

A. M. July 10, 1825, Port Bowen. Clock gaining at an assumed rate 69ˢ.88 in 24 h.

Hygʳ. { Temp. 50°. / Dew Pᵗ. 43°. } Barʳ. { Begᵍ. 29.710 mer. 48°. / Endᵍ. 29.712 — 48°. } = 29.771 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
49,7	7 12 18	12 22	12 20	1.15	1.110	697	697,5	86221,760	86221,938	2.014	86223,774	86223,952
50,0	23 55	24 00	23 57,5	1.07	1.035	698	698,5	86222,116	86222,293	1.752	86223,868	86224,045
49,9	35 33	35 39	35 36	1.00	0.965	698	698,5	86222,116	86222,293	1.522	86223,638	86223,815
49,8	47 11	47 18	47 14,5	0.93	0.895	699	698,5	86222,470	86222,293	1.309	86223,779	86223,602
50,0	58 50	58 56	58 53	0.86	0.830	699	700	86222,470	86222,823	1.122	86223,592	86223,945
50,3	8 10 29	10 37	10 33	0.80	0.770	698	698,5	86222,116	86222,293	0.969	86223,085	86223,262
50,2	22 7	22 16	22 11,5	0.74	0.720	700	700	86222,823	86222,823	0.848	86223,671	86223,671
50,0	34 47	34 56	34 51,5	0 70	0.680	700	700,5	86222,823	86223,000	0.756	86223,579	86223,756
50,0	45 27	45 37	45 32	0.66	0.635	701	701	86223,176	86223,176	0.659	86223,835	86223,835
50,1	57 8	57 18	57 13	0.61								
50,0	Mean.							Vibrations in 24 h. at Temp. 50°.			86223,647	86223,765

P.M. July 10, 1825, Port Bowen. Clock gaining at an assumed rate 69ˢ.88 in 24 h.

Hygʳ. { Temp. 50°.5. / Dew Pᵗ. 42°. } Barʳ. { Begᵍ. 29.712 mer. 48°.5. / Endᵍ. 29.713 — 48°.5. } = 29.773 mean cor. to temp. of pend.

50,5	10 36 35	36 38	36 36,5	1 18	1.140	697	697,5	86221,760	86221,938	2.125	86223,885	86224,063
50,5	48 12	48 16	48 14	1.10	1.060	697	697,5	86221,760	86221,938	1.837	86223,597	86223,775
50,5	59 49	59 54	59 51,5	1.02	0,985	698	698,5	86222,116	86222,293	1.586	86223,702	86223,879
50,5	11 11 27	11 33	11 30	0 95	0.915	698	698,5	86222,116	86222,293	1.369	86223,485	86223,662
50,3	23 5	23 12	23 8,5	0.88	0.850	699	699	86222,470	86222,470	1.178	86223,648	86223,648
50,0	34 44	34 51	34 47,5	0.82	0.795	699	699,5	86222,470	86222,647	1.033	86223,503	86223,680
50,0	46 23	46 31	46 27	0.77	0.745	700	700,5	86222,823	86223,000	0.907	86223,730	86223,907
50,1	58 3	58 12	58 7,5	0.72	0.695	702	701,5	86223,527	86223,352	0.788	86224,315	86224,140
50,2	12 9 45	9 53	9 49	0.67	0.645	699	699,5	86222,470	86222,647	0.680	86223,150	86223,327
50,3	21 24	21 33	21 28,5	0.62								
50,29	Mean.										86223,668	86223,787
0,29	Diff. to 50°.							Correction for Temp. o°.29.			+ 0,123	+ 0,123
								Vibra. in 24 h. at Temp. 50°.			86223,791	86223,910

Observation of Coincidences at Port Bowen (2nd Series)—continued.

P. M. July 10, 1825, Port Bowen. Clock gaining at an assumed rate 69ˢ.88 in 24 h.

Hygʳ. { Temp. 50°. Dew Pt. 42°.

Barʳ. { Begᵍ. 29.714 mer. 48°.5. Endᵍ. 29.714 — 49°. } = 29.774 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.		o	s.	s.			vib.		
49,8	12 56 19	56 22	56 20,5	1.21	1.165	697	698	86221,760	86222,116	2.219	86223,979	86224,335
49,8	1 7 56	8 1	7 58,5	1.12	1.080	698	697,5	86222,116	86221,938	1.907	86224,023	86223,845
50,0	19 34	19 38	19 36	1.04	1.010	697	698	86221,760	86222,116	1.666	86223,426	86223,782
50,0	31 11	31 17	31 14	0.98	0.950	698	699,5	86222,116	86222,647	1.476	86223,592	86224,123
50,0	42 49	42 58	42 53,5	0.92	0.885	700	699	86222,823	86222,470	1.280	86224,103	86223,750
50,1	54 29	54 36	54 32,5	0.85	0.820	700	700	86222,823	86222,823	1.099	86223,922	86223,922
50,5	2 6 9	6 16	6 12,5	0.79	0.760	697	698	86221,760	86222,116	0.944	86222,704	86223,060
50,7	17 46	17 55	17 50,5	0.73	0.705	699	700	86222,470	86222,823	0.812	86223,282	86223,635
50,6	29 25	29 36	29 30,5	0.68	0.655	700	700	86222,823	86222,823	0.701	86223,524	86223,524
50,5	41 5	41 16	41 10,5	0.63								
50,20	Mean.										86223,617	86223,775
0,20	Diff. to 50°.							Correction for Temp. 0°.20.			+ 0,086	+ 0,086
								Vibra. in 24 h. at Temp. 50°.			86223,703	86223,861

Table I. (*2nd Series.*)

Times by Clock at Transits of Stars, at Port Bowen, July, 1825.

Stars.	6th.	7th.	8th.	9th.	10th.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Arcturus .	4 25 42,54	4 22 56,58	4 20 10,95	4 17 24,54	4 14 38,80
α Lyræ .	8 48 32,41	8 45 46,75	8 43 00,93	8 40 14,81	8 37 28,75

Table II.

Transits of Sun. Times by Clock at the moment of Mean Noon.

6th.	8th.	9th.	10th.
h. m. s.	h. m. s.	h. m. s.	h. m. s.
9 16 28,54	9 18 48,99	9 19 59,03	9 21 9.36

Table III.

Rates of the Clock by the Stars. (Gaining.)

Stars.	From 6 to 7	From 6 to 8	From 6 to 9	From 6 to 10	From 7 to 8	From 7 to 9	From 7 to 10	From 8 to 9	From 8 to 10	From 9 to 10
	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
Arcturus	69.96	70.12	69.92	69.98	70.29	69.90	69.99	69.51	69.84	70.18
α Lyræ	70.25	70.16	70.04	69.99	70.09	69.93	69.91	69.79	69.81	69.85
Mean	70.11	70.14	69.98	69.99	70.19	69.92	69.95	69.65	69.83	70.02
Proport^{n}. for rate in 3^{m} 56^{s}	+ .19	+ .19	+ .19	+ .19	+ .19	+ .19	+ .19	+ .19	+ .19	+ .19
Rate of the Clock, gaining in a mean solar day...	70.30	70.33	70.17	70.18	70.38	70.11	70.14	69.84	70.02	70.21

Table IV.

Rates of the Clock by the Sun. (Gaining.)

From 6 to 8	From 6 to 9	From 6 to 10	From 8 to 9	From 8 to 10	From 9 to 10
s.	s.	s.	s.	s.	s.
70.22	70.16	70.20	70.04	70.18	70.33

Table V. *Second Series.*

Vibrations of the Pendulum at Port Bowen, computed at the assumed rate of the Clock, viz. 86469,88 vibrations in a mean solar day.

Date.	Time of the day.	Barometer.	Thermom.	Vibrations in 24 h. at Temp. 50°.	
				Disappearance.	Mean of Disap. and Re-ap.
		inches.	o		
July 6th	P. M.	29,755	50,59	86223,366	86223,524
—	—	,757	50,74	86223,445	86223,604
7th	A. M.	29,749	52,83	86223,451	86223,630
—	—	,742	53,75	86223,512	86223,652
—	P. M.	,746	52,70	86223,473	86223,632
—	—	,756	53,09	86223,459	86223,599
8th	A. M.	29,810	50,15	86223,261	86223,379
—	—	,810	49,36	86223,282	86223,420
—	P. M.	,812	50,36	86223,399	86223,597
—	—	,819	50,49	86223,530	86223,688
9th	A. M.	29,812	51,37	86223,616	86223,715
—	P. M.	,811	52,75	86223,699	86223,858
—	—	,804	52,77	86223,609	86223,769
10th	A. M.	29,772	49,74	86223,525	86223,683
—	—	,771	50,00	86223,647	86223,765
—	P. M.	,773	50,29	86223,791	86223,910
—	—	,774	50,20	86223,703	86223,861
Mean.		29,781	51,25	86223,516	86223,664

Table VI. *Second Series.*

By the Stars.

July 1825.		Computed vibrations of the pendulum in 24 h. the clock gaining 69″.88 (assumed rate) in a mean solar day.		Observed rate of the clock by Stars' transits.	Corrections to vibrations for diff. of rate and 69″.88.	Correct number of vibrations made by the pendulum in a mean solar day at temperature 50°.		No. of Stars observed.	Interval in days.	Factors.
From	To	Disappearance.	Mean of Disap. and Re-ap.			Disappearance.	Mean of Disap. and Re-ap.			
				s.	vib.					
7th A. M.	7th P. M.	86223,474	86223,628	70,30	+ 0,420	86223,894	86224,048	2	1	2
	8th —	86223,421	86223,575	70,33	+ 0,450	86223,871	86224,025	2	2	4
	9th —	86223,481	86223,631	70,17	+ 0,290	86223,771	86223,921	2	3	6
	10th —	86223,530	86223,677	70,18	+ 0,300	86223,830	86223,977	2	4	8
8th A. M.	8th P. M.	86223,343	86223,521	70,38	+ 0,500	86223,843	86224,021	2	1	2
	9th —	86223,485	86223,632	70,11	+ 0,230	86223,715	86223,862	2	2	4
	10th —	86223,551	86223,695	70,14	+ 0,260	86223,811	86223,955	2	3	6
9th A. M.	9th P. M.	86223,641	86223,781	69,84	— 0,040	86223,601	86223,741	2	1	2
	10th —	86223,656	86223,794	70,02	+ 0,140	86223,796	86223,794	2	2	4
10th A. M.	10th P. M.	86223,666	86223,805	70,21	+ 0,230	86223,896	86224,035	2	1	2
Mean						86223,803	86223,938	Sum of Factors		40

Table VII. *(2nd Series.)*

By the Sun.										
July, 1825.		Computed vibrations of the pendulum in 24 h. the clock gaining 69s.88 (assumed rate) in a mean solar day.		Observed rate of the clock by Sun's transits.	Corrections to vibrations for diff. of rate and 69s.88.	Correct number of vibrations made by the pendulum in a mean solar day at temperature 50°.		No. of Stars observed.	Interval in days.	Factors.
From	To	Disappearance.	Mean of Disap. and Re-ap.			Disappearance.	Mean of Disap. and Re-ap.			
				s.	vib.					
6th, P. M.	8th, A. M.	86223,406	86223,555	70.22	+ 0,340	86223,746	86223,895	2	2	4
	9th —	86223,436	86223,585	70.16	+ 0,280	86223,716	86223,865	2	3	6
	10th —	86223,485	86223,634	70 20	+ 0,320	86223,805	86223,954	2	4	8
8th, P. M.	9th, A. M.	86223,515	86223,667	70.04	+ 0,160	86223,675	86223,827	2	1	2
	10th —	86223,561	86223,725	70.18	+ 0,300	86223,861	86224,025	2	2	4
9th, P. M.	10th, A. M.	86223,620	86223,769	70.33	+ 0,450	86224,070	86224,219	2	1	2
				Mean.		86223,812	86223,964	Sum of Factors		26

In this series, the number of vibrations made by the pendulum in 24 hours of mean solar time, as obtained from the observations of the disappearance of the white disk, and employing the rates furnished by the transits of stars, is 86223,803, and by the rates, from the sun's transits 86223,812. By the mean of the observations of the disappearance and re-appearance of the disk, the number of vibrations is 86223,938 by the rates, from the stars' transits, and 86223,964 by the transits of the sun. But the sum of the factors for the stars being 40, and for the sun 26, the mean number of vibrations in 24 hours, by the observation of the disappearance of the white disk is 86223,806, and by the mean of its disappearance and re-appearance 86223,948. If to each of these, we apply the corrections, 0v,330 for elevation, and 6v,116 for the buoyancy of the atmosphere, at the mean pressure 29,781 inches, and temperature 51°,25 of FAHRENHEIT, we shall arrive at the total number of vibrations which would have been made by the pendulum in a mean solar day, the temperature being 50° of FAHRENHEIT, in vacuo, at the level of the sea at Port Bowen ; and are

By the observation of disappearance - - - 86230,252

By the mean of disappearance and re-appearance - 86230,394

By the first series, the total number of vibrations of the pendulum in 24 hours was

By the observation of disappearance - - 86230,147

By the mean of disappearance and re-appearance 86230,288

The sums of the factors, however, being 275,5 in this series, and only 66 in the second, we obtain for the final number of vibrations at Port Bowen,

By the method of disappearance - - 86230,172
By the mean of disappearance and re-app. 86230,313.

From the above data and number of vibrations made by the same pendulum from the mean of both series at Greenwich, viz.

by the method of disappearance - - 86159,368
and by mean of disappearance and re-app. 86159,500,

together with the *assumed length* of the seconds' pendulum at Greenwich 39,13911 inches; the length of the seconds' pendulum at Port Bowen is found to be nearly 39,203464 inches, by the method of disappearance, and by the mean of disappearance and re-appearance 39,203472 inches; and comparing these with 39,13911 inches, the *assumed length* in lat. 51° 28′ 39″ N. as before stated, the diminution of gravity from the pole to the equator will be by the method of disappearance ,0054152, the ellipticity of the earth $\frac{1}{309,13}$, and the length of the equatorial pendulum 39,009805 inches; and by the mean of disappearance and re-appearance, the diminution of gravity from the pole to the equator will be ,0054159, the ellipticity of the earth $\frac{1}{309,19}$, and the length of the equatorial pendulum 39,009789 inches of Sir GEORGE SCHUCKBURGH'S scale.

The length of the pendulum vibrating seconds, not having been determined at Greenwich, but at Mr. BROWNE'S house in London, it must be remembered that the above *lengths* are not the *true lengths* of the pendulum, but are merely given for the sake of comparison.

III. *Concluding Series at the Royal Observatory at Greenwich.*

November 1825.

Comparisons of the Clock, with the Observatory Transit Clock.

Date.	Time by Clock.	Time by the Observatory Clock.	Mean Time at Greenwich.	Clock Slow of Mean Time.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
7th, A. M.	2 25 00	12 2 31,52	8 56 33,44	6 31 33,44
— Noon	5 25 00	15 3 1,38	11 56 34,06	6 31 34,06
— P. M.	8 34 00	18 12 32,95	3 5 34,13	6 31 34,13
8th, A. M.	2 17 29,93	11 59 00,00	8 49 6,15	6 31 36,22
— Noon	5 33 57,34	15 16 00,00	0 5 33,85	6 31 36,51
— P. M.	8 24 00	18 6 30,86	2 55 36,74	6 31 36,74
9th, A. M.	2 23 00	12 8 29,77	8 54 38,21	6 31 38,21
— Noon	5 35 00	15 21 1,54	0 6 38,40	6 31 38,40
— P. M.	8 23 00	18 9 29,38	2 54 38,60	6 31 38,60
10th, A. M.	2 25 00	12 14 28,64	8 56 39,89	6 31 39,89
— Noon	5 36 00	15 26 00,22	0 7 40,06	6 31 40,06
— P. M.	8 39 00	18 29 30,39	3 10 40,14	6 31 40,14
11th, A. M.	2 36 00	12 29 28,47	9 7 41,16	6 31 41,16
— Noon	5 28 00	15 21 56,91	11 59 41,32	6 31 41,32
— P. M.	9 13 00	19 7 34,24	3 44 41,62	6 31 41,62

From the above Table of Comparisons the following, of rates losing, has been deduced.

Times of Comparison.	From 7 to 8	From 7 to 9	From 7 to 10	From 7 to 11	From 8 to 9	From 8 to 10	From 8 to 11	From 9 to 10	From 9 to 11	From 10 to 11
	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
A. M...	2.794	2.386	2.150	1.930	1.978	1.828	1.638	1.678	1.469	1.260
Noon ..	2.435	2.163	1.996	1.814	1.892	1.776	1.608	1.660	1.465	1.271
P. M...	2.630	2.241	2.002	1.862	1.853	1.687	1.606	1.522	1.483	1.445
Rate losg in a mean solar day	2.62	2.26	2.05	1.87	1.91	1.76	1.62	1.62	1.47	1.32

Observations of Coincidences at Greenwich, November, 1825.

Height above the level of the sea 181,5 feet.

A. M. November 7th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begᵍ. 29.121 mer. 45°. / Endᵍ. 29.125 — 45°. } = 29.115 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
43,5	3 21 00	21 5	21 2,5	1.16	1.120	710	710	.....	.....	2.050	.....	.....
43,6	32 50	32 55	32 52,5	1.08	1.040	710	711	.....	.....	1.769	.....	.....
43,8	44 40	44 47	44 43,5	1.00	0.970	711	711	.....	.....	1.538	.....	.....
43,9	56 31	56 38	56 34,5	0.94	0.910	710	710,5	.....	.....	1.353	.....	.....
44,0	4 8 21	8 29	8 25	0.88	0.855	712	712	.....	.....	1.194	.....	.....
44,0	20 13	20 21	20 17	0.83	0.795	711	711,5	.....	.....	1.034	.....	.....
44,2	32 4	32 13	32 8,5	0.76	0.735	712	712	.....	.....	0.882	.....	.....
44,5	43 56	44 5	44 0,5	0.71	0.685	713	712,5	.....	.....	0.766	.....	.....
44,7	55 49	55 57	55 53	0.66	0.640	712	713	.....	.....	0.671	.....	.....
44,9	5 7 41	7 51	7 46	0.62								
44,11	Means.					711,11	711,5	86155,135	86155,268	1.251	86156,386	86156,519

P. M. November 7th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begᵍ. 29.125 mer. 45°.5. / Endᵍ. 29.144 — 46°.2. } = 29.126 mean cor. to temp. of pend.

46	6 29 36	29 43	29 39,5	1.16	1.120	709	707,5	.....	.....	2.050	.....	.....
46	41 25	41 29	41 27	1.08	1.040	706	707	.....	.....	1.769	.....	.....
46	53 11	53 17	53 14	1.00	0.965	708	708,5	.....	.....	1.523	.....	.....
46	7 4 59	5 6	5 2,5	0.93	0.900	708	708,5	.....	.....	1.324	.....	.....
46	16 47	16 55	16 51	0.87	0.840	709	709,5	.....	.....	1.154	.....	.....
46,2	28 36	28 45	28 40,5	0.81	0.780	709	709	.....	.....	0.996	.....	.....
46,4	40 25	40 34	40 29,5	0.75	0.720	709	710	.....	.....	0.846	.....	.....
46,3	52 14	52 25	52 19,5	0.69	0.665	710	710	.....	.....	0.722	.....	.....
46,2	8 4 4	4 15	4 9,5	0.64	0.620	710	711	.....	.....	0.628	.....	.....
46,2	15 54	16 7	16 0,5	0.60								
46,13	Means.					708,667	709,0	86154,297	86154,412	1.224	86155,521	86155,636

Observations of Coincidences at Greenwich—continued.

Height above the level of the sea 181,5 feet.

A. M. November 8th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begˢ. 29.251 mer. 39°.5. / Endˢ. .163 — 42°.0. } = 29.200 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance	Mean of Disap. and Re-ap.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
40,0	3 27 28	27 33	27 30,5	1.18	1.135	712	712	.....	.....	2.106	.....	.....
40,2	39 20	39 25	39 22,5	1.09	1.055	712	713	.....	.....	1.820	.....	.....
40,6	51 12	51 19	51 15,5	1.02	0.985	714	714	.....	.....	1.587	.....	.....
40,9	4 3 6	3 13	3 9,5	0.95	0.915	713	713,5	.....	.....	1.368	.....	.....
41,0	14 59	15 7	15 3	0.88	0.850	714	714	.....	.....	1.181	.....	.....
41,0	26 53	27 1	26 57	0.82	0.785	713	714,5	.....	.....	1.009	.....	.....
41,2	38 46	38 57	38 51,5	0.75	0.725	714	714	.....	.....	0.857	.....	.....
41,9	50 40	50 51	50 45,5	0.70	0.675	713	713,5	.....	.....	0.744	.....	.....
42,1	5 2 33	2 45	2 39	0.65	0.630	715	714,5	.....	.....	0.649	.....	.....
42,1	14 28	14 39	14 33,5	0.61								
41,1	Means.					713,333	713,667	86155,892	86156,005	1.258	86157,150	86157,263

P. M. November 8th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begˢ. 29.104 mer. 42°.8. / Endˢ. .029 — 45°. } = 29.058 mean cor. to temp. of pend.

43,1	6 26 34	26 40	26 37	1.14	1.095	710	709	.....	.....	1.961	.....	.....
43,2	38 24	38 28	38 26	1.05	1.015	708	709,5	.....	.....	1.684	.....	.....
43,2	50 12	50 19	50 15,5	0.98	0.945	710	711	.....	.....	1.461	.....	.....
43,7	7 2 2	2 11	2 6,5	0.91	0.880	710	710	.....	.....	1.266	.....	.....
44,0	13 52	14 1	13 56,5	0.85	0.825	710	709,5	.....	.....	1.111	.....	.....
44,2	25 42	25 50	25 46	0.80	0.775	710	710,5	.....	.....	0.981	.....	.....
44,5	37 32	37 41	37 36,5	0.75	0.725	708	709	.....	.....	0.858	.....	.....
44,8	49 20	49 31	49 25,5	0.70	0.675	712	711	.....	.....	0.745	.....	.....
45,0	8 1 12	1 21	1 16,5	0.65	0.625	708	709	.....	.....	0.638	.....	.....
45,5	13 00	13 11	13 5,5	0.60								
44,12	Means.					709,556	709,833	86154,603	86154,698	1.189	86155,792	86155,887

Observations of Coincidences at Greenwich — continued.

Height above the level of the sea 181,5 feet.

A. M. November 9th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begᵍ. 28,969 mer. 44°.5. } = 28,973 mean cor.
{ Endᵍ. 29,000 — 46°.0. } to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. in 24 h. cor. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
44,8	3 17 52	17 57	17 54,5	1.13	1.090	706	706,5	.....	.....	1.943	.....	.....
44,9	29 38	29 44	29 41	1.05	1.015	704	705,5	.....	.....	1.684	.....	.....
45,0	41 22	41 31	41 26,5	0.98	0.945	707	706,5	.....	.....	1.461	.....	.....
45,2	53 9	53 17	53 13	0.91	0.875	707	707,5	.....	.....	1.250	.....	.....
45,7	4 4 56	5 5	5 00,5	0.84	0.810	706	707	.....	.....	1.072	.....	.....
45,9	16 42	16 53	16 47,5	0.78	0.755	707	706,5	.....	.....	0.931	.....	.....
46,0	28 29	28 39	28 34	0.73	0,705	707	707,5	.....	.....	0.812	.....	.....
46,1	40 16	40 27	40 21,5	0.68	0.655	708	708	.....	.....	0.701	.....	.....
46,5	52 4	52 15	52 9,5	0.63	0.610	706	707	.....	.....	0.608	.....	.....
46,8	5 3 50	4 3	3 56,5	0.59								
45,69	Means.					706,444	706,889	86153,530	86153,684	1.162	86154,692	86154,846

P. M. November 9th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begᵍ. 29,016 mer. 47°.5. } = 29,023 mean cor.
{ Endᵍ. 29,050 — 47°. } to temp. of pend.

47,7	6 25 10	25 15	25 12,5	1.13	1.090	702	702	.....	.....	1.943	.....	.....
47,8	36 52	36 57	36 54,5	1.05	1.015	702	704	.....	.....	1.684	.....	.....
47,7	48 34	48 43	48 38,5	0.98	0.950	705	704,5	.....	.....	1.476	.....	.....
47,7	7 00 19	00 27	00 23	0.92	0.885	705	704,5	.....	.....	1.281	.....	.....
47,6	12 4	12 11	12 7,5	0.85	0.820	705	705,5	.....	.....	1.099	.....	.....
47,6	23 49	23 57	23 53	0.79	0.760	705	706,5	.....	.....	0.943	.....	.....
47,7	35 34	35 45	35 39,5	0.73	0.705	706	706	.....	.....	0.812	.....	.....
47,3	47 20	47 31	47 25,5	0.68	0 650	706	707	.....	.....	0.691	.....	.....
47,0	59 6	59 19	59 12,5	0.62	0.600	708	707	.....	.....	0.589	.....	.....
47,0	8 10 54	11 5	10 59,5	0.58								
47,51	Means.					704,889	705,222	86152,990	86153,106	1.169	86154,159	86154,275

Observations of Coincidences at Greenwich—continued.

Height above the level of the sea 181,5 feet.

A. M. November 10th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begᵍ. 28.640 mer. 43°.5. / Endᵍ. 28.620 — 44°.5. } = 28.613 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. corr. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-app.		Disappearance.	Mean of Disap. and Re-app.
o	h. m. s.	m. s.	m. s.	o	o	s.	s.			vib.		
44,0	3 19 1	19 8	19 4,5	1.10	1.060	706	706	.....	.....	1.837	.....	.....
44,0	30 47	30 54	30 50,5	1.02	0.980	706	706	.....	.....	1.572	.....	.....
44,1	42 33	42 40	42 36,5	0.94	0.910	706	707	.....	.....	1.353	.....	.....
44,1	54 19	54 28	54 23,5	0.88	0.850	707	707,5	.....	.....	1.181	.....	.....
44,1	4 6 6	6 16	6 11	0.82	0.790	706	707,5	.....	.....	1.021	.....	.....
44,2	17 52	18 5	17 58,5	0.76	0.740	709	708	.....	.....	0.896	.....	.....
44,3	29 41	29 52	29 46,5	0.72	0.700	706	707,5	.....	.....	0.801	.....	.....
44,4	41 27	41 41	41 34	0.68	0.655	708	708,5	.....	.....	0.702	.....	.....
44,5	53 15	53 30	53 22,5	0.63	0.605	710	709	.....	.....	0.598	.....	.....
44,8	5 5 5	5 18	5 11,5	0.58								
44,25	Means.					707,111	707,444	86153,761	86153,876	1.107	86154,868	86154,983

P. M. November 10th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begᵍ. 28,617 mer. 45°. / Endᵍ. 28,613 — 45°. } = 28,597 mean cor. to temp. of pend.

45,2	6 31 10	31 16	31 13	1.16	1.120	703	703,5	.....	.....	2.051	.....	.....
45,2	42 53	43 00	42 56,5	1.08	1.050	705	705	.....	.....	1.803	.....	.....
45,2	54 38	54 45	54 41,5	1.02	0.980	705	706	.....	.....	1.572	.....	.....
45,2	7 6 23	6 32	6 27,5	0.94	0.910	706	706	.....	.....	1.353	.....	.....
45,2	18 9	18 18	18 13,5	0.88	0.850	706	706	.....	.....	1.181	.....	.....
45,2	29 55	30 4	29 59,5	0.82	0.780	705	707	.....	.....	0.996	.....	.....
45,2	41 40	41 53	41 46,5	0.74	0.710	706	706	.....	.....	0.823	.....	.....
45,2	53 26	53 39	53 32,5	0.68	0.655	707	707	.....	.....	0.702	.....	.....
45,2	8 5 13	5 26	5 19,5	0.63	0.605	706	707	.....	.....	0.598	.....	.....
45,2	16 59	7 14	17 6,5	0.58								
45,2	Means.					705,444	705,944	86153,183	86153,357	1.231	86154,414	86154,588

Observations of Coincidences at Greenwich—continued.

Height above the level of the sea 181,5 feet.

A. M. November 11th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begᵍ. 29.273 mer. 42°. / Endᵍ. 29.300 — 43°. } = 29.280 mean cor. to temp. of pend.

Temp.	Time of Disappearance.	Time of Re-appearance.	Mean of Disappearance and Re-appearance.	Arc of vibration.	Mean Arc.	Interval in seconds of Clock.		Observed vibrations in 24 h.		Correct. for Arc.	Vibra. corr. for Arc.	
						Disap.	Disap. & Re-ap.	Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
°	h. m. s.	m. s.	m. s.	°	°	s.	s.			vib.		
42,0	3 14 45	14 48	14 46,5	1.14	1.095	706	707,5	.....	.....	1.961	.....	.....
42,0	26 31	26 37	26 34	1.05	1.010	708	708	.....	.....	1.668	.....	.....
42,1	38 19	38 25	38 22	0.97	0.935	708	708,5	.....	.....	1.431	.....	.....
42,4	50 7	50 14	50 10,5	0.90	0.870	709	709,5	.....	.....	1.237	.....	.....
42,7	4 1 56	2 4	2 00	0.84	0.810	708	708,5	.....	.....	1.072	.....	.....
42,9	14 44	14 53	14 48,5	0.78	0.750	711	710,5	.....	.....	0.919	.....	.....
42,9	25 35	25 43	25 39	0.72	0.700	708	709,5	.....	.....	0.801	.....	.....
42,9	37 23	37 34	37 28,5	0.68	0.655	710	710,5	.....	.....	0.701	.....	.....
43,0	49 13	49 25	49 19	0.63	0.605	710	709,5	.....	.....	0.598	.....	.....
43,0	5 1 3	1 14	1 8,5	0.58								
42,59	Means.					708,667	709,111	86154,297	86154,450	1.154	86155,451	86155,604

P. M. November 11th, 1825, Royal Observatory.
Clock losing at a mean rate 1ˢ.87 per diem.

Barʳ. { Begᵍ. 29.302 mer. 43°. / Endᵍ. 29.333 — 45°. } = 29.312 mean cor. to temp. of pend.

44,5	5 37 54	37 57	37 55,5	1.15	1.110	705	706,5	.....	.....	2.014	.....	.....
44,2	49 39	49 45	49 42	1.07	1.030	705	705,5	.....	.....	1.733	.....	.....
44,2	6 1 24	1 31	1 27,5	0.99	0.955	707	707,5	.....	.....	1.491	.....	.....
44,4	13 11	13 19	13 15	0.92	0.880	705	707	.....	.....	1.266	.....	.....
44,4	24 56	25 8	25 2	0.84	0.810	709	707,5	.....	.....	1.072	.....	.....
44,3	36 45	36 54	36 49,5	0.78	0.750	708	708	.....	.....	0.919	.....	.....
44,2	48 33	48 42	48 37,5	0.72	0.700	708	709	.....	.....	0.801	.....	.....
44,3	7 00 21	00 32	00 26,5	0.68	0 655	708	708	.....	.....	0.701	.....	.....
44,3	12 9	12 20	12 14,5	0.63	0.605	708	709	.....	.....	0.598	.....	.....
44,4	23 57	24 10	24 3,5	0.58								
44,32	Means.					707,0	707,556	86153,722	86153,914	1.177	86154,899	86155,091

Vibrations of the Pendulum at the Royal Observatory at Greenwich, November 1825.

The Clock making 86398,13 vibrations in a mean solar day at a mean rate.

Date.	Barom.	Ther.	Diff. Temp. & 50	Vibra. in 24 h. cor. for Arc by		Correction for Temp.	Vibra. of pend. in 24 h. at temp. of 50° by	
				Disappearance.	Mean of Disap. and Re-ap.		Disappearance.	Mean of Disap. and Re-ap.
	Inches.	o	o			vib.		
Nov. 7th A.M.	29.115	44.11	5.89	86156,386	86156,519	— 2.491	86153,895	86154,028
— P.M.	29.126	46.13	3.87	86155,521	86155,636	— 1.637	86153,884	86153,999
8 A.M.	29.200	41.10	8.90	86157,150	86157,263	— 3.765	86153,385	86153,498
— P.M.	29.058	44.12	5.88	86155,792	86155,887	— 2.487	86153,305	86153,400
9 A.M.	28.973	45.69	4.31	86154,692	86154,846	— 1.823	86152,869	86153,023
— P.M.	29.023	47.51	2.49	86154,159	86154,275	— 1.053	86153,106	86153,222
10 A.M.	28.613	44.25	5.75	86154,868	86154,983	— 2.432	86152,436	86152,551
— P.M.	28.597	45.20	4.80	86154,414	86154,588	— 2.030	86152,384	86152,558
11 A.M.	29.280	42.59	7.41	86155,451	86155,604	— 3.134	86152,317	86152,470
— P.M.	29.312	44.32	5.68	86154,899	86155,091	— 2.403	86152,496	86152,688
Mean.	29.297	44.50					86153,008	86153,144

Results.

From	To	Correct number of vibrations of pend. in a mean solar day.	
		Disappearances.	Mean of Disap, and Re-ap.
Nov. 7th A. M.	Nov. 8th P. M.	86152,867	86152,981
———	9th P. M.	86153,017	86153,138
———	10th P. M.	86152,978	86153,105
———	11th P. M.	86153,008	86153,144
8th A. M.	9th P. M.	86153,126	86153,246
———	10th P. M.	86153,024	86153,152
———	11th P. M.	86153,037	86153,176
9th A. M.	10th P. M.	86152,949	86153,088
———	11th P. M.	86153,001	86153,152
10th A. M.	11th P. M.	86152,958	86153,117
	Mean.....	86152,996	86153,130
	Correction for buoyancy.....	+ 6,041	+ 6,041
	——— elevation	+ 0,450	+ 0,450
	Final No. of vibra. in vacuo at the level of the sea, temp. 50°. (Fah.)	86159,487	86159,621

By this experiment, it appears that the final number of vibrations which would have been made by the pendulum at Greenwich in 24 mean solar hours at the level of the sea, in vacuo, and at the temperature of 50° of FAHRENHEIT, by the

method of disapp. of the white disk is - 86159,487
and by the mean of its disapp. and re-app. 86159,621

But from the final results deduced from the experiment made at Greenwich in April 1824, previous to leaving England, the total number of vibrations which would have been made by the same pendulum under the above circumstances, by the

method of disappearance, was - - - 86159,250
and by the mean of disapp. and re-app. - 86159,380

Having already stated, what I have considered to be the cause of the difference in the number of vibrations of the pendulum in these experiments; the following arithmetical means of the results of the series in April 1824, and November 1825, are to be considered as the proper number of vibrations of the pendulum, at Greenwich, to be compared with those obtained at Port Bowen, and are by the method of

disappearance of the white disk - 86159,368
and by the mean of its disapp. and re-app. 86159,500.

II. *Observations on the diurnal variation of the magnetic needle, at the Whale Fish Islands, Davis's Strait.* By Lieutenant Henry Foster, *R. N. F. R. S.*

Previous to leaving England in the spring of 1824, I had determined upon making a series of observations on the daily variation of the magnetic needle, during our stay, at the different places which might be visited by the Expedition. Accordingly, soon after our arrival at the Whale Fish Islands, for the purpose of transhipping the stores from the Transport which had accompanied us thus far; the instrument for observing the diurnal variation was landed, and placed on a pedestal in a small octagonal observatory.

The length of the needle was 11 inches, and weighed 120 grains; it rested on a pivot; and its direction when the *sun* was on the magnetic meridian I assumed, for distinction's sake, the zero of my scale. The observations were continued for three days only; and as the brass work of the instrument was afterwards found to be magnetic, the results obtained are, of course, too doubtful to be considered of any great value taken singly; but as it was these observations which first indicated to me the agency of the *sun*, in producing the interesting phenomenon of the daily variation, I have thought it right to give them in detail, together with such remarks as occurred to me at this early stage of the enquiry, as preliminary to the more extended and exact observations made at Port Bowen by Captain Parry, the other Officers of the Expedition, and myself, an account of which accompanies this communication to the Royal Society.

Observations on the daily variation of the magnetic needle at the Whale Fish Islands, June 1824. Variation 70° 2′ W.

June 29th. Instrument adjusted when ⊙ was on mag^{t}. meridian.							June 30th. Instrument re-adjusted when ⊙ was on mag^{t}. meridian.						
Apparent Time of Observation.	Temperature. Inst.	Air.	Barometer.	Reading of south end of needle.	Direction of south end of needle.	Remarks, &c.	Apparent Time of Observation.	Temperature. Inst.	Air.	Barometer.	Reading of south end of needle.	Direction of south end of needle.	Remarks, &c.
h. m.	+ °	+ °	inches.	° ′ ″			h. m.	+ °	+ °	inches.	° ′ ″		
A. M. 7 35	49	45		4 14 00	South end of needle going to the eastward.	⊙ on magnetic meridian.	A. M. 7 30	52	46		4 10 30	South end of the needle drawn to the eastward.	⊙ on magnetic meridian.
10 10	55	45	30,00	20 15			10 10	53	46	29,94	7 30		
11 10	56½	45	.....	20 15			11 10	53	47	.....	26 30		
P.M. 12 10	56¾	45	.....	22 00			P.M. 12 10	53	47	.....	29 30		
1 10	57	45	.....	29 00		15′ max. westerly variation. ⊙ west by compass.	1 20	53½	47	.....	30 30		23′ max. westerly variation. ⊙ west by compass. Cloudy weather.
2 10	56	47	.....	23 00	South end going to the westward.		2 20	54	47	.....	24 00	South end of needle going to the westward.	
3 10	56	47	30,02	19 30			3 10	56	47	29,91	20 00		
4 10	57	47	.....	21 00			4 10	55	46	.....	9 00		
5 10	58	46	.....	21 00						.....			
6 47	65	45	.....	19 00			6 46	56½	45	.....	12 00		
7 10	57	44	.....	19 00	Needle unsettled.	⊙ on mag. meridian.	7 10	54	44	.....	8 30		SSE wind with rain.
8 10	56	42	.....	19 00			8 10	49	43½	.....	9 30		
9 10	57	41	30,00	13 00			9 10	49	43	29,78	13 00		
10 10	56	41	.....	17 00		Light airs and fine weather.	10 10	46	42	.....	9 30		
11 10	47	40	.....	19 00			11 10	43½	42	.....	9 30		
Mid^{t} 12 10	45½	40	.....	17 00			Mid. 12 10	42	41½	.....	9 30		

July 1st.						
Apparent Time of Observation.	Temperature. Inst.	Air.	Barometer.	Reading of south end of needle.	Direction of south end of needle.	Remarks, &c.
h. m.	+ °	+ °	inches.	° ′ ″		
A. M. 7 30	44	42½		4 10 00	S. end to South end of the west- needle drawn ward. to the east.	⊙ on mag. mer.
10 30	42	39	29,97	8 30		
11 10	43	39	.....	12 30		23′ 30″ max. W. var. ⊙ west by compass.
P.M. 12 10	43	39	.....	10 00		
1 10	44	40	.....	23 30		
2 10	45	40	.....	8 00		
3 10	46	44	29,98	00 00		

Here the observations were interrupted by the re-shipment of the instruments preparatory to the departure of the expedition.

From these observations it appears, that the maximum westerly variation happened about a quarter past one o'clock P. M. at which time the sun was nearly west by compass. The observations, however, were not continued after midnight; consequently the time of maximum easterly could not be determined, nor the total amount of the daily variation.

III. *Magnetical Observations at Port Bowen, &c. A. D.* 1824-25, *comprehending observations on the diurnal variation and diurnal intensity of the horizontal needle; also on the Dip of the magnetic needle at Woolwich, and at different stations, within the Arctic circle. By Captain* W. E. Parry, *F. R. S. and Lieutenant* Henry Foster, *F. R. S.*

The daily variation of the horizontal needle was first observed in London by Mr. Graham, in the year 1722; but in consequence of its small amount, it has always been considered amongst the minor phenomena which the magnetic needle presents. Mr. Barlow, however, having explained a method of encreasing the amount of this daily change very considerably, in any latitude,* this phenomenon began to assume a different character, and seemed to furnish a subject of highly interesting, if not of useful, enquiry.

Therefore, soon after our arrival at Port Bowen, an attempt was made to obtain the diurnal variation of the magnetic needle at this place, with an instrument constructed by Mr. Dollond for that purpose, and which had been used at the Whale Fish Islands. But the weight of the needle occasioned so much friction on the point of support, that no movement could be detected; and after several trials, which it is unnecessary here to detail, (and in the course of which it was discovered that the brass composing the instrument was in every part highly magnetic) it was wholly laid aside as useless in these latitudes.

* Phil. Trans. for 1823.

The needles, distinguished by Nos. 1 and 2 in the following tables were *suspended*, instead of *supported*, and were contained within a small wooden box having a glass cover. The centre of each was made exactly to coincide with the centre of motion of the index of a common HADLEY'S quadrant, graduated to minutes as usual, the box being fixed upon the index and moving with it. The agate cup of each needle was just allowed to touch a fine steel point of support, in order to preserve their correct centres. No. 1 needle belonged to an azimuth compass on Capt. KATER'S construction, its lozenge shape being that figured in the Appendix to the Voyage of 1819-20, p. cix; except that this needle was rounded at the corners forming the extremities of its transverse diameter. Its weight (with the addition of mica ends increasing its length to eight inches for the purpose of more accurate observation) was 104 grains, that of the needle alone being 50 grains.

No. 2 needle was formed of clock spring, and furnished by Mr. CHRISTIE, for some experiments to be made with it under the influence of magnets. Its shape has been already described by that gentleman in his paper on this subject, in the Philosophical Transactions for the year 1823.

The length of this needle was 4,9 inches, but increased by mica ends to about ten inches, in which state it weighed 96 grains, that of the needle alone being 51 grains.

Both these needles were delicately suspended by a few fine threads of floss silk, from seven to eight inches in length, having no torsion, and passing up through a copper cylinder over a small brass pulley. A leaden weight just equivalent to that of the needle was then attached to the

other end of the silk, in order to adjust it so that it might barely touch the centre or point of support.

No. 3 needle, which was that of a common ship's azimuth compass, and weighed 146 grains, was suspended like the other two, but simply contained within an air-tight box having glass ends. A sight of card paper being fixed towards each extremity of the needle, the amount of variation was obtained, by observing the coincidence of the sights through a small telescope traversing upon an arc of ten fee radius, and consequently placed at that distance from the needle. A vernier attached to the telescope, and moving with it, gave the reading to the nearest minute. This needle was afterwards used exclusively for obtaining the changes in the magnetic intensity, for which it was found remarkably well adapted; the instant of the coincidence of the two sights being easily observable through the telescope to two-tenths of a second, by means of a chronometer held to the ear. During the absence of daylight, these observations were made by candlelight, transmitted through a sheet of oiled paper, fixed against the glass end of the box, farthest from the observer.

The observations were made at the commencement by Lieutenant Foster and Captain Parry, but were subsequently carried on in regular watches, and the needles visited every hour during four successive months, by Lieutenants Sherer and Ross, and Messieurs Crozier, Richards and Head. When any extraordinary change, however, appeared to be going on, the needles were more closely watched; and every phenomenon, such as the aurora borealis, meteors, clouds, the kind and degree of light, the moon's position, and the temperature within and without, were at all times care-

fully noted. In the following tables these phenomena, with the exception of the temperature, have necessarily been omitted, on account of the great length to which their insertion would have extended this communication; but an abstract of all the particulars relative to one of the needles, No. 2, has been made by Lieutenant FOSTER, and is given in continuation of this series; diagrams exhibiting graphically the various deflections of needle No. 1, for which we are indebted to the ingenuity of Mr. HOOPER, are also subjoined.

The original register of the whole is preserved and can easily be referred to, should any of the observed phenomena, beyond those which are here given, be considered likely to have influenced the motion of the needles. As far, however, as our own observations extended, we have reason to believe that on no occasion were the needles in the slightest degree affected, either by the aurora, meteors, or any other perceptible atmospheric phenomenon.

Soon after the observations were commenced, it was ascertained that twice in every four and twenty hours the needles moved past a certain point, which may be denominated the zero, or mean magnetic meridian; a fact, which was first rendered clearly apparent, from the accompanying diagrams already mentioned, by which it appears that in every instance except one, both needles every day passed the line in question. On a single day, February 24, the needle No. 2 did not arrive at it during its eastern motion.

The means of the times of the needle passing this zero, as deduced from four months continued observations, is, $6^h\,15^m$ A. M., and $4^h\,37^m$ P. M.; the mean time in each month being as follows:

1825	A. M.	P. M.
January - - -	$6^h\,00^m$	$4^h\,00^m$
February - -	6 30	4 00
March - - -	5 30	5 00
April - - - -	7 00	5 30
Mean	6 15	4 37

To avoid the insertion of many useless figures in the tables, the resulting *amount of easterly or westerly deflection on each side of the zero has been computed.*

The maximum westerly variation at Port Bowen appears, from these observations, generally to have occurred between the hours of 10^h A. M. and 1^h P. M., the mean result of one hundred and twenty days' observations being $11^h\,49^m$ A. M. The minimum westerly variation, or the greatest deflection of the north end of the needle to the eastward, took place between 8^h P. M. and 2^h A. M., the mean time, deduced as above, being $10^h\,1^m$ P. M.

In a few instances the maximum deflection of the needle to the westward occurred as early as 8^h A. M., and as late as 3^h P. M.; and in like manner, the greatest deflection eastward took place at 2^h and 3^h P. M., on some few occasions. In all these anomalous cases, however, it was remarked, from simultaneous observations on the times of vibration of a suspended horizontal needle, that these irregularities were evidently due to an extraordinary alteration in its intensity, which produced a deflection contrary to the regular order of the motion of the needle.

The diurnal change of direction appears, by these observations, to have been seldom less than one degree, and sometimes to have amounted to 5, 6, and even 7 degrees, and there can be no doubt that the changes in this amount were

more or less due to the position or influence of the sun, and probably of the moon, on the terrestrial magnetic sphere; but the particular laws of this influence is a question of great delicacy, and of intricate research, and will be best left to the investigations of those who are theoretically conversant with these subjects.

TABLES,

Shewing the observed daily variation of the horizontal needle from December 10th to December 31st, 1824, and from January 1st to May 31st, 1825, at Port Bowen. Lat. 73° 14′ N. Long. 88° 54′ W. Mean dip 88° 01′,4. N Mean variation 124° W.

December.	Mean Time of Observation.	Deflections of Needle No. 1 from the line of Zero.	Temp.	December.	Mean Time of Observation.	Deflections of Needle No. 1 from the line of Zero.	Temp.	December.	Mean Time of Observation.	Deflections of Needle No. 1 from the line of Zero.	Temp.
1824			—	1824	A. M.		—	1824	P. M.		—
10th	P. M.			12th	h. m.	° ′	°	13th	h. m.	° ′	°
	h. m.	° ′			1 0	1 14 E	15		4 0	0 21 E	24
	8 0	0 55 E			2 0	1 16	15		7 0	0 17	20
	9 0	1 09			3 0	1 16	16		10 0	0 19	19
11th	A. M.		°		4 0	1 16	16		12 0	0 19	23
	9 0	0 26	14		5 0	1 16	16	14th	A. M.		
	P. M.				6 0	1 14	15		12 0	0 20	24
	2 0	0 22	15		7 0	1 07	14		P. M.		
	6 0	0 30	15		8 0	1 06	9		7 0	0 27	25
	7 0	0 49	13½		12 0	0 58			9 0	0 27	
	8 0	0 59	13½		P. M.			15th	A. M.		
	10 0	1 04	12½		1 0	0 52			3 0	0 36	28
	11 0	1 06	14		3 0	0 22	4		P. M.		
	12 0	1 11	13½	13th	A. M.				1 0	0 09	29

Note. The registered temperatures, throughout these observations, are according to FAHRENHEIT'S scale, and are all *below zero*, in those columns that have the sign minus (—) only, placed at the top, and *above zero* in those that have the sign plus (+) inserted in like manner. Those columns, however, at the top of which, these signs appear thus, (∓) contain observations, both *below*, and *above zero*, which are pointed out, by their respective signs, being prefixed to the several observations of each denomination.

December.	Mean Time of Observation.	Deflections of Needle No. 1 from the line of Zero.	Temp.
1824	P. M.		—
15th	h. m.	° ′	°
	3 0	0 28 E	32
	7 0	0 28	33
	9 0	0 17	33
16th	A. M.		
	10 0	0 10	30
	11 0	0 10	28½
	12 0	0 10	30
	P. M.		
	3 0	0 15	34
	8 0	0 19	34
	11 0	0 19	34
	12 0	0 19	32
17th	A. M.		
	5 0	0 24	28
	10 0	0 42 W	29
	12 0	0 26	28
	P. M.		
	1 0	0 41	28
	2 0	0 41	28
	3 0	0 26	28
	4 0	0 19	28
	6 0	0 16 E	28
	7 0	0 36	27
	9 0	0 39	24
	10 0	0 42	24
	12 0	0 47	23
18th	A. M.		
	0 30	0 39	24
	1 20	0 59	
	3 00	0 25	
	12 0	0 16	
	P. M.		
	1 0	0 24	22
19th	A. M.		
	12 0	0 06 W	14
	P. M.		
	4 0	0 19 E	
	7 0	0 12	
	11 0	0 21	
20th	A. M.		
	11 35	1 06 W	14
	P. M.		
	6 0	0 19 E	22
	7 25	0 29	24
	9 0	0 33	35
	10 0	0 42	
	11 0	0 28	
	12 0	0 46	
21st	A. M.		
	9 30	0 49 W	
	12 00	0 29	31
	P. M.		
	1 15	0 20	32

December.	Mean Time of Observation.	Deflections of Needle No. 1 from the line of Zero.	Temp.
1824	P. M.		—
21st	h. m.	° ′	°
	5 00	0 12 W	26
	6 00	0 21 E	27
	8 00	0 34	27
	11 05	0 27	25
	11 55	0 36	24
22d	A. M.		
	10 0	0 51 W	25
	12 0	0 18	24
	P. M.		
	1 0	0 16	25
	5 0	0 14 E	27
	7 0	0 17	26
	9 0	0 23	25½
	10 0	0 25	
23d	A. M.		
	7 30	0 23	26
	10 00	0 10 W	25
	12 00	0 04 E	32
	P. M.		
	1 20	0 09	
	5 0	0 01	31
	6 0	0 17	32
	7 0	0 43	
	8 0	0 29	31
	9 0	0 22	31
	10 0	0 59	30
	11 0	0 59	32
	12 0	0 53	31
24th	A. M.		
	1 0	0 24	27
	2 0	0 32	30
	3 0	0 21	28
	4 0	0 19	27
	5 0	0 27	
	6 0	0 01	24
	7 0	0 11	22
	8 0	0 05	20
	9 0	0 05	19
	10 0	0 09	18
	10 35	0 09	
	11 00	0 17	17
	11 30	0 04	
	12 00	0 04	17
	P. M.		
	2 0	0 35 W	15
	11 0	0 08 E	16
	12 0	0 04	15
25th	A. M		
	1 0	0 06	16
	2 0	0 06	18
	2 30	0 07 W	19
	11 50	0 14	19

December.	Mean Time of Observation.	Deflections of Needle No. 1 from the line of Zero.	Temp.
1824	P. M.		—
25th	h. m.	° ′	°
	0 30	0 14 W	19
	1 00	0 04	20
	1 30	0 10	20
	7 00	0 02 E	24
	8 00	0 08	24
26th	A. M.		
	1 0	0 01	28
	2 0	0 15	28
	3 0	0 13	28
	4 0	0 18	28
	12 0	0 05 W	28
	P. M.		
	1 0	0 15 E	27
	5 0	0 21	26
	8 0	0 21	26
	9 0	0 21	26
	10 50	0 12	52
27th	A. M.		
	3 0	0 22	19½
	6 0	0 16	19
	7 0	0 14	18
	8 0	0 14	18
	10 0	0 01	18
	12 0	0 03	
28th	A. M.		
	P. M.		
	2 20	0 09	9
	7 0	0 25	11
	7 30	0 25	11
29th	A. M.		
	6 30	0 35 W	9
	10 0	1 21	11
	11 0	0 55	11
	11 30	0 34	8
	12 0	0 58	6
	P. M.		
	1 0	0 03 E	11½
	1 15	0 23 W	10
	1 30	0 16	10
	1 45	0 04 E	9½
	2 03	0 03 W	10½
	4 30	0 11 E	13
	5 00	0 11	13
	6 00	0 21	13
	7 0	0 28	13
	8 0	0 31	15
	9 0	0 29	15
	10 0	0 25	15
	11 0	0 27	16
	12 0	0 38	
30th	A. M.		
	1 0	1 01	16
	1 30	0 53	15½

December.	Mean Time of Observation.	Deflections of Needle No. 1 from the line of Zero.	Temp.
1824	A. M.		—
30th	h. m.	° ′	°
	2 0	0 40 E	15½
	3 0	0 31	14
	4 0	0 31	13
	9 20	1 46 W	13
	9 35	1 46	
	10 0	2 03	12
	10 20	1 56	12
	10 35	1 37	12
	11 00	1 34	12
	11 30	1 50	12
	12 0	1 34	12
	P. M.		
	6 0	0 42 E	11
	8 0	0 29	11
	10 0	0 22	11½
	10 30	1 01	11
	11 0	2 26	11
	11 20	2 44	11
	11 40	1 18	11
	12 0	0 51	10½
31st	A. M.		
	3 0	0 22	11
	4 0	0 18	11½
	5 15	0 18	15
	6 0	0 22	16
	7 0	0 19 W	15
	7 20	0 42	10
	8 0	0 22	13
	10 10	0 43	13½
	10 40	0 57	13½
	11 0	2 15	12
	11 20	2 04	12½
	11 40	1 02	12½
	12 0	1 13	12
	P. M.		
	0 20	1 22	12
	0 40	1 44	11½
	1 0	0 16	11
	1 20	0 08 E	10
	1 40	0 18	10
	5 0	0 27	12
	6 0	0 15	12
	8 0	0 40	19
	9 0	0 49	19
	10 0	0 44	22
	11 0	0 51	22
	11 30	0 57	22½
	12 0	1 25	22½

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
1st	h. m.	° ′	° ′	°
	0 40	1 18 E	.....	26
	1 20	1 09	.....	26½
	2 00	1 3	.....	25
	3 0	0 37	.....	27
	4 0	0 24	.....	26½
	5 0	0 30	.....	26
	6 0	0 15	.....	26
	7 0	0 07	.....	26
	8 0	0 15		
	10 0	0 06 W		
	11 30	0 06		
	12 0	.....	0 43 W	
	P. M.			
	0 30	0 36	.....	25
	1 0	0 03	0 50	19
	1 30	0 25 E	.....	25
	2 0	0 24	0 16	22
	3 0	0 24	0 09	22
	6 0	0 17	.....	26
	8 20	0 26	0 13 E	25½
	9 0	1 01	.....	27½
	—	.....	0 21	25
	11 0	0 38	0 16	27
	Mid.	0 58	0 30	27
2d	A. M.			
	0 30	0 49	.....	26
	1 00	0 37	0 30	26½
	1 37	0 37	0 28	25½
	6 0	0 08	0 02 W	25
	8 0	0 02	0 10	24½
	9 0	0 02	0 10	24½
	11 55	0 11 W	0 23	25
	0 30	Zero	0 13	25
	P. M.			
	1 0	.....	0 03	24
	1 30	0 07	0 02	25
	2 0	0 23 E	0 10 E	
	5 0	0 37	0 10	26
	6 0	0 19	0 11 W	26½
	7 0	0 22	0 11	27
	8 0	0 36	0 16 E	27
	9 0	0 36	0 16	27½
	10 0	0 19	0 08	26
	10 30	0 16	0 04	25½
	11 00	0 13	0 03	25½
	12 0	0 18	0 06	26
3d	A. M.			
	0 30	0 13	0 03	25
	1 0	0 16	0 09	25
	1 50	0 16	0 09	24½
	2 30	0 16	0 09	24½
	6 05	0 20	0 23	26½

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
3d	h. m.	° ′	° ′	°
	6 35	0 24 E	0 23 E	26½
	7 05	0 07	0 29	25½
	7 35	Zero	0 29	25½
	8 5	0 08 W	0 26	25½
	9 0	.....	0 16	24
	10 0	0 35	0 02 W	26
	10 30	0 35	0 01	25
	11 0	0 43	Zero	25
	11 30	0 35	Zero	25½
	12 00	0 21	0 19 E	26
	P. M.			
	0 30	0 13	.....	27
	0 57	0 22	0 08	25½
	1 30	0 22	0 08	26
	2 5	0 10	0 28	27½
	4 05	0 02	0 28	27½
	5 05	0 07 E	0 28	29½
	6 05	0 15	0 33	29½
	7 05	0 20	0 33	29½
	8 00	0 20	0 33	29½
	9 00	0 18	0 33	29½
	10 00	0 17	0 36	32
	11 0	0 05	0 32	32½
	12 0	0 12	0 47	33
4th	A. M.			
	1 0	0 12	0 39	33½
	2 0	0 08	0 36	34
	5 0	0 04	0 29	32½
	6 0	0 04	0 16	32
	7 0	0 04 W	0 16	31½
	8 0	0 15	0 13	29
	9 15	0 20	0 01	27
	10 05	0 32	0 10 W	26
	11 05	0 27	0 01	26½
	12 05	0 18	0 18 E	27
	P. M.			
	1 05	0 07	0 26	26
	2 00	0 01	0 26	26
	3 00	0 06 E	0 46	26
	4 00	0 06	0 31	25½
	5 06	0 06	0 31	26
	6 00	0 06	0 30	25½
	7 00	0 06	0 30	27
	8 00	0 06	0 30	26½
	9 0	0 02 W	0 30	27½
	10 0	Zero	0 30	28
	11 0	Zero	0 30	27½
	12 0	0 01 E	0 36	28½
5th	A. M.			
	1 5	0 01	0 31	30
	2 02	0 06	0 40	30½
	3 02	0 08	0 31	30½

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
5th	h. m.	° ′	° ′	°
	4 0	0 01 E	0 28 E	30
	5 0	Zero	0 21	30
	6 0	0 06 W	0 07	29½
	7 0	0 18	0 01 W	30
	8 0	0 22	0 01	30
	9 05	0 29	0 02 E	30
	9 35	0 33	Zero	29
	1 05	0 37	0 12 W	29½
	10 35	0 48	0 17	29½
	11 5	0 49	0 30	29½
	11 35	0 49	0 22	30½
	P. M.			
	0 5	0 37	0 13	31
	0 35	0 41	0 03	30½
	1 05	0 29	Zero	31
	1 35	0 35	0 11	31½
	2 05	0 41	0 11	31½
	3 00	0 35	0 01	32
	4 5	0 15	0 27 E	32½
	5 2	0 01 E	0 39	32½
	6 17	0 33	0 51	32½
	7 07	0 30	0 49	34
	8 00	0 51	1 25	32½
	9 0	1 09	1 42	32½
	10 0	1 22	1 49	32½
	11 0	1 18	1 41	32
	12 0	1 47	2 03	32
6th	A. M.			
	1 05	0 28	0 42	32
	1 35	0 09	0 37	32
	2 05	Zero	0 37	32
	2 35	Zero	0 37	32
	3 05	Zero	0 26	31½
	4 05	0 09	0 37	31
	5 02	0 19 W	0 16	32
	6 05	0 34	0 08	31½
	7 0	1 05	0 33 W	29
	8 0	1 18	0 44	28
	9 52	1 35	1 00	27½
	10 45	1 35	0 32	27⅓
	12 00	0 06	0 11 E	28
	P. M.			
	0 45	.....	0 08	27
	2 00	0 37	0 16 W	28
	2 35	0 17	0 09	28½
	4 50	0 07	0 18 E	29
	6 05	0 13 E	0 57	29½
	6 57	0 21	0 59	30
	8 00	0 25	0 56	30
	9 0	0 37	1 02	30
	10 0	0 37	1 02	29½
	11 2	0 53	1 50	31
	12 1	1 23	1 50	31

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
7th	h. m.	° ′	° ′	°
	1 6	1 23 E	1 34 E	31
	2 05	0 53	1 01	31
	3 05	0 43	1 12	31
	4 05	0 17	0 47	30½
	5 05	0 08	0 39	31
	6 05	0 04 W	0 36	31
	7 00	0 10	0 09	31
	7 57	0 17	0 02	31
	9 27	1 39	0 57 W	32
	11 56	1 26	0 53	33½
	P. M.			
	2 55	0 40	0 03	33
	3 57	0 06 E	0 27 E	32½
	5 07	0 22	0 46	33
	7 05	0 24	1 01	32½
	8 02	0 26	0 50	32½
	9 0	0 18	0 50	31
	10 2	0 18	0 53	32
	11 0	0 22	0 48	30
	12 0	0 34	1 06	30
8th	A. M.			
	1 15	0 16	0 30	29½
	2 05	0 08	0 34	29
	3 05	0 08	0 49	29½
	4 05	0 08	0 09	30
	5 10	0 09 W	0 09	30½
	6 05	0 14	0 04 W	30½
	7 04	0 31	0 30	29½
	8 05	0 34	0 18	29½
	10 02	0 19	0 01	29½
	11 02	0 07	0 08 E	30
	P. M.			
	3 52	0 02	0 19	30½
10th	A. M.			
	7 0	0 02	0 22	29½
	10 0	0 21	0 09 W	30
	11 10	.....	0 03	30
	12 0	0 22	.....	31
	P. M.			
	1 5	0 27	0 18	32
	3 22	0 01 E	0 10 E	32
	4 0	0 04	0 19	31½
	5 0	0 13	0 37	31½
	6 0	0 15	0 59	32
	7 0	0 15	0 59	31½
	8 0	0 20	1 00	32½
	9 01	0 25	1 05	32½
	10 7	0 25	1 01	33
	11 2	0 27	1 05	34
	12 2	0 27	1 01	34
11th	A. M.			
	1 05	0 42	1 01	4½
	2 5	0 48	1 02	33½

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
11th	h. m.	° ′	° ′	°
	3 5	0 34 E	0 50 E	33½
	4 5	0 08 W	Zero	33½
	5 05	0 05 E	0 18	34½
	6 05	0 04 W	0 01 W	34
	7 02	0 20	0 01	34½
	8 00	0 25	0 42	34
	9 02	0 36	0 44	32½
	10 5	1 06	0 16	33½
	11 0	0 49	0 10	34½
	12 0	0 52	0 54	34
	P. M.			
	1 17	0 36	0 49	34½
	2 04	0 30	0 03	35
	4 02	0 01	0 19 E	36½
	5 02	0 08 E	0 18	35
	6 02	0 17	0 28	36
	7 02	0 17	0 28	36
	8 12	0 17	0 58	36
	9 5	0 16	0 56	36
	10 5	0 16	0 49	34
	11 5	0 09	0 46	35
	12 0	0 10	0 46	35
12th	A. M.			
	1 03	0 09	1 07	35
	2 4	0 08	0 48	35½
	3 5	0 08	0 46	35½
	4 0	0 08	0 45	34½
	5 6	0 08	0 29	30
	6 5	0 01 W	0 23	35½
	7 2	0 01	0 23	35½
	8 2	0 01	0 23	35½
	9 5	0 07	0 19	36½
	10 5	0 05	0 04 W	36
	11 5	0 16	Zero	35½
	12 2	0 16	0 06 E	35
	P. M.			
	0 55	0 15	0 06	36½
	2 05	0 02	0 15	37
	3 05	0 04	0 13	36
	4 00	0 06	0 34	35½
	5 5	Zero.	0 36	35½
	6 5	0 07 E	0 28	36
	7 5	0 07	0 28	36
	8 5	0 09	0 28	36
	9 2	0 05	0 27	35½
	10 3	0 05	0 36	35½
	11 8	0 14	0 36	36
	12 10	0 15	0 32	37
13th.	A. M.			
	1 5	0 15	0 46	35½
	2 0	0 11	0 41	35

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
13th.	h. m.	° ′	° ′	°
	3 5	0 6 E	0 41 E	33½
	4 0	0 6	0 36	32½
	5 5	0 6	0 26	32½
	6 5	0 6	0 17	32
	7 5	Zero.	0 17	29
	8 2	Zero.	0 13	28
	9 10	0 5 W	0 11	26½
	10 4	0 07	0 11	26
	11 4	0 07	0 01	25½
	12 2	0 09	0 20	23½
	P. M.			
	1 3	0 22	0 09	22½
	1 40	.....	0 16	24
	1 57	0 02 E	0 16	23
	3 4	0 02	0 32	18½
	4 10	0 02	0 32	18
	5 5	0 02	0 27	17½
	6 5	0 02	0 23	16½
	7 5	0 02 W	0 22	16
	8 5	Zero.	0 20	16
	9 7	Zero.	0 20	16
	10 0	Zero.	0 26	17
	10 10	.....	0 34	16½
	11 5	0 04	0 40	16½
	12 5	0 17 E	0 16	16½
14th.	A. M.			
	1 05	0 18	0 20	18½
	2 03	0 25	0 27	18½
	3 03	0 28	0 27	19
	4 02	0 22	0 27	19
	5 5	0 06	0 33	19
	6 05	0 06 W	0 27	19
	7 7	0 06	0 27	19
	P. M.			
	1 25	0 21	0 13 W	19
	2 05	0 22	Zero	18
	3 05	0 28	0 03	19
	4 00	0 44	0 11	19½
	5 5	0 16	0 33 E	19½
	6 5	0 04 E	0 56	19½
	7 05	0 06	1 01	19½
	8 05	0 44	1 07	19½
	10 07	1 05	1 29	18½
	11 05	1 28	1 08	18½
	12 7	0 13	0 31	18½
15th.	A. M.			
	1 5	0 59	1 01	22½
	2 0	0 35	0 44	22½
	3 5	0 28	0 50	23
	4 0	0 15	0 50	25
	5 5	0 01 W	0 37	26

January.	Mean Time of Observation.	Deflections from the line of zero. Needle No. 1.	Needle No. 2.	Needle No. 3.	Temp.
1825.	A. M.				—
15th	h. m.	° ′	° ′		°
	6 5	0 01 W	0 37 E	.....	25½
	7 5	0 01	0 27	.....	25½
	8 5	0 02 E	0 27	.....	25
	9 9	0 11 W	0 27	.....	25½
	10 2	0 09	0 02	.....	26
	11 7	0 51	0 55 W	.....	26
	12 7	0 24	1 33	.....	26
	P. M.				
	0 57	1 23	1 18		
	1 00	0 53			
	1 5	0 45	.....	.....	26½
	1 8	0 45			
	1 20	.....	0 12	.....	25
	1 38	0 55	0 44	.....	27
	1 45	1 09			
	1 48	1 24			
	1 52	1 27	0 51		
	2 0	.....	0 51		
	3 8	0 29	0 21 E		
	3 37	.....	0 47	.....	25
	4 3	0 12 E	0 33	.....	25½
	5 5	0 15	0 41	.....	25½
	6 5	0 15	0 41	.....	25½
	7 5	0 15	0 42	0 11 E	26
	8 5	0 15	0 49	0 05	26
	9 2	0 21	0 48	0 14	27
	10 6	0 43	1 28	0 53	27
	11 5	0 37	1 23	0 53	26
	12 0	1 18	1 33	1 21	26
16th	A. M.				
	1 10	1 18	1 33	0 57	25
	2 8	2 04	2 39	1 42	25½
	2 53	1 24	1 59	1 29	26
	4 06	0 48	0 54	0 39	25½
	5 08	0 01	0 33	0 01	26
	6 05	0 03	0 33	0 08	27
	7 05	0 07 W	0 03	0 07 W	27
	8 05	0 01 E	0 11	0 07	27
	9 06	0 14 W	0 13 W	0 13	27½
	12 5	1 26	1 33	2 14	28
	P. M.				
	1 8	1 26	1 12	1 17	29
			0 34	0 55	29
			0 38		
	3 2	.....	0 23	0 43	29
	3 40	.....	.....	0 12 E	
	4 8	0 24 E	0 26 E	.....	28½
	4 15	.....	.....	Zero	
	5 06	0 23	0 39	0 14	30
	6 05	0 23	0 42	0 17	30
	7 7	0 24	0 42	0 17	30

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Needle No. 3.	Temp.
1825.	A. M.				—
16th	h. m.	° ′	° ′	° ′	°
	8 5	0 24 E	0 50 E	0 35 E	29½
	9 2	0 30	0 48	0 35	31
	10 5	0 54	0 47	0 43	31½
	11 5	0 56	0 53	0 43	32
	12 5	0 52	0 43	0 29	32
17th	A. M.				
	1 05	0 20	0 36	0 10	31½
	2 2	0 24	0 33	0 10	31½
	3 2	0 28	0 41	0 17	31½
	4 1	0 17	0 27	0 14	31½
	5 0	0 26	.....	0 10	30½
	5 32	.....	0 14	.....	30
	6 7	0 26	0 14	0 10	30
	7 6	0 25 W	1 04 W	1 10 W	30
	8 5	1 20	1 12	1 28	30
	8 25	.....	0 39	0 26	29
	9 9	0 03	Zero	0 24	28
	10 5	0 16	0 20	0 36	28
	11 5	0 23	0 10	0 26	28
	12 5	0 47	0 06	0 18	27
	P. M.				
	1 02	0 02	0 04	0 45	27½
	2 02	0 37	0 37	0 40	27
	3 02	0 35	0 40	0 28	27
	4 00	0 20 E	0 10 E	0 12 E	26
	5 6	0 04	0 27	0 33	25½
	6 7	0 39	0 27	0 40	25½
	7 6	0 39	0 27	0 40	25½
	8 7	0 45	0 46	0 41	25½
	9 10	0 28	0 33	0 12	26
	10 7	0 39	1 17	0 48	26½
	11 02	0 22	0 20	0 27	26
	12 07	0 22	0 20	0 25	25
18th	A. M.				
	1 5	0 22	0 44	0 26	25½
	2 05	0 31	0 50	0 32	25½
	3 05	0 23	1 04	0 50	26
	4 4	0 25	0 35	0 25	25
	5 7	0 25	0 35	0 25	20
	6 6	0 45 W	0 08 W	0 05 W	21½
	7 6	0 08	0 08	0 05	20½
	8 6	Zero	0 10 E	Zero	20½
	10 5	1 03	0 48 W	0 53	19
	11 4	1 23	0 56	1 13	20½
	12 5	1 33	1 27	1 42	22
	P. M.				
	1 19	0 38	0 31	0 24	23
	2 15	1 03	0 52	0 53	23
	3 13	0 06	Zero	0 06	23
	4 03	Zero	0 09 E	0 11 E	23
	4 56	0 10 E	0 20	0 26	22

January.	Mean Time of Observation.	Deflections from the line of Zero.			Temp.
		Needle No. 1.	Needle No. 2.	Needle No. 3.	
1825.	A. M.				—
18th	h. m.	° ′	° ′	° ′	°
	6 10	0 53 E	1 28 E	0 26 E	23
	7 0	0 19	1 05	0 26	23
	8 0	0 19	1 05	0 30	21
	9 10	0 10	0 16	0 10	21½
19th	A M.				
	8 0	.....	0 22 W	0 24 W	21
	P. M.				
	1 30	0 15 W	0 12	0 07	20
	2 2	.....	0 26	0 27	19
	2 10	.....	0 42	0 49	19
	2 15	.....	.....	0 31	17
	2 28	0 05	0 41	0 31	17½
	3 0	.....	0 10	0 18 E	18
	4 5	.....	0 32 E	0 03	18
	5 7	.....	0 03 W	0 13	18
	6 7	.....	0 03	0 11	18
	7 7	.....	0 03	0 11	18
	8 7	.....	0 57 E	0 31	16½
	9 7	.....	0 39	0 36	19
	9 56	0 19 E	0 32	0 23	18½
	11 3	0 19	0 26	0 09	19
	12 4	0 23	0 31	0 18	19
20th	A. M.				
	1 11	0 28	0 34	0 28	22
	2 5	0 51	1 14	0 35	23
	3 5	0 52	1 13	0 34	24
	4 0	0 35	0 04	0 29	24
	5 6	0 07 W	0 01 W	0 04 W	24
	6 5	0 07	0 32	0 21	24½
	7 5	0 07	0 19	0 04	24½
	8 5	0 04 E	0 11	Zero	26
	9 10	0 04 W	0 14	0 01 E	25½
	10 04	0 12	0 28	0 13 W	23½
	11 04	0 21	0 21	0 13	23½
	11 59	0 31	0 24	0 13	23
	P. M.				
	1 2	0 13	0 37	0 37	24
	1 57	0 02 E	0 53	0 35	24
	3 01	0 05 W	0 51	0 11 E	25
	4 0	0 02	0 34	0 05 W	25½
	5 5	0 06 E	0 15 E	0 03 E	26½
	6 0	0 05 W	0 01	0 08	27
	6 55	0 04 E	0 01	0 08	28
	8 05	0 04	0 01	0 10	28½
	9 08	0 13	0 06	0 10	29
	10 0	0 13	0 06	0 10	29
	11 7	0 13	0 06	0 10	28½
	12 9	0 11	0 04	0 09	28½
21st	A. M.				
	1 02	0 01 W	0 03	0 08	28
	2 0	0 07	0 05	0 13	28

January.	Mean Time of Observation.	Deflections from the line of Zero.			Temp.
		Needle No. 1.	Needle No. 2.	Needle No. 3.	
1825.	A. M.				—
21st	h. m.	° ′	° ′	° ′	°
	3 0	0 05 W	0 04 E	0 13 E	28
	4 6	0 01	Zero	0 07	26½
	6 2	0 01	Zero	0 07	27½
	7 2	0 01	0 07 W	0 07	28
	8 2	0 11	0 07	0 07	28
	9 37	0 22	0 13	0 08 W	28½
	11 5	0 12	0 20	0 16	30
	12 2	0 02	0 14	0 17 E	30
	P. M.				
	1 40	.....	0 26	0 12 W	30
	1 58	0 17	0 06 E	0 05	30
	2 10	.....	0 02	0 05	30
	3 7	0 01	0 46	0 07 E	30
	4 0	0 01	0 46	0 07	30
	5 5	0 14 E	0 46	0 14	30½
	6 0	0 13	0 51	0 14	30½
	7 2	0 14	0 47	0 14	30½
	8 2	0 14	0 47	0 14	30½
	9 10	0 14	0 28	0 15	31
	10 0	0 14	0 28	0 15	31½
	11 0	0 14	0 28	0 15	28½
	12 0	0 10	0 28	0 15	29
22d	A. M.				
	1 10	0 08	0 20	0 13	28½
	2 5	0 01	0 10	0 10	28½
	3 4	0 01	0 10	0 10	29
	4 0	0 07	0 10	0 10	29
	5 10	0 07	0 10	0 10	30½
	6 2	0 03	0 04	0 01	30
	7 00	0 15 W	0 11 W	0 11 W	31
	8 00	0 26	0 22	0 17	30
	10 2	0 33	0 03	0 36	27½
	11 2	0 22	0 05 E	0 23	27
	12 2	0 18	0 17	0 19	27½
	P. M.				
	1 01	0 31	0 27 W	0 04 E	29
	1 57	0 25	0 24	0 22 W	29
	3 02	0 19	0 06	0 08	27½
	3 59	0 10	0 01 E	0 02	26½
	5 00	0 10	0 16 W	0 06 E	26
	6 0	0 08	0 16	0 06	25½
	7 0	0 08	0 16	0 06	24½
	8 0	0 02 E	0 01 E	0 06	24½
	9 10	0 03	0 02	0 06	24½
	10 0	0 03	0 02	0 06	25
	11 0	0 42	0 09	0 36	27
	12 0	0 42	0 48	0 36	27½
23d	A. M.				
	1 5	0 48	0 18	0 45	29
	2 0	0 13	0 01 W	0 13	29
	3 0	0 13	0 01	0 10	27

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Needle No. 3.	Temp.
1825.	A. M.				—
23d	h. m.	° ′	° ′	° ′	°
	4 0	0 04 E	0 07 W	0 08 E	25½
	5 0	0 08 W	0 15	0 05 W	25½
	6 0	0 08	0 15	0 05	25½
	7 0	0 08	0 15	0 05	25½
	8 0	0 02	0 11	0 01	25
	9 10	0 16	0 23	0 14	25
	12 15	1 17	1 00	1 09	25
	P. M.				
	1 10	1 26	0 51	1 05	25½
	2 5	0 03	0 27	0 18	26
	3 2	0 11	0 08	0 08 E	26
	4 10	0 14 E	0 07	0 15	29
	5 5	0 18	0 02	0 17	29½
	6 0	0 18	0 02	0 17	30
	7 0	Zero	0 03	0 09	30½
	8 2	0 07	0 16 E	0 12	32
	9 0	.....	0 09	.....	32
	9 52	0 10	0 09	0 12	32
	11 5	Zero	0 09	0 12	32½
	12 0	0 04	Zero	0 12	32½
24th	A. M.				
	1 10	0 05	0 06	0 20	33½
	2 00	0 09	0 06	0 21	33½
	3 00	0 09	0 06	0 21	33½
	4 00	0 09	0 06	0 08	34
	5 0	0 09	0 06	0 08	36½
	6 0	0 09	0 06	0 08	37
	7 0	0 09 W	0 15 W	0 08 W	37
	8 0	0 09	0 15	0 03 E	37
	9 5	0 02 E	0 12	0 03	36
	10 5	0 10 W	0 17	0 14 W	35
	11 5	0 20	0 25	0 14	34
	12 1	0 03	0 13	Zero	34½
	P. M.				
	1 8	0 10	0 13	Zero	35
	2 8	0 16	0 17	0 02	35½
	3 5	0 26	0 20	0 13	35½
	3 59	0 12	0 14	0 09	35½
	5 00	0 02 E	0 03	0 09 E	35
	6 0	0 14	0 18 E	0 09	34½
	7 0	0 02	0 18	0 01	34
	8 0	0 02	0 23	0 17	35
	9 3	0 12	0 18	0 15	34
	10 2	0 12	0 18	0 17	34½
	11 2	0 12	0 18	0 14	35
	12 2	0 12	0 28	0 14	35½
25th	A. M.				
	1 05	0 03	0 38	0 17	35
	1 57	0 03	0 36	0 09	35
	3 05	0 10	0 31	0 09	36
	4 05	0 14	0 38	0 09	36

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Needle No. 3.	Temp.
1825.	A. M.				—
25th	h. m.	° ′	° ′	° ′	°
	5 00	0 03 E	0 38 E	0 09 E	37
	6 0	0 03	0 38	0 09	37
	7 0	Zero	0 28	0 02	37
	8 0	0 06 W	0 10 W	0 17 W	37
	9 7	0 09	0 18	0 08	38
	10 5	0 17	0 18	0 11	38
	11 1	0 33	0 27	0 26	38
	12 0	0 20	0 20	0 08	38½
	P. M.				
	1 3	0 40	0 31	0 08	39½
	2 5	0 40	0 29	0 15	39
	3 5	0 06	1 04	Zero	40
	4 2	0 02 E	0 19	0 04 E	40
	5 0	0 02	0 19	0 01 W	40½
	6 1	0 02	0 19	0 09 E	40½
	7 0	0 23	0 05	0 15	40½
	7 58	0 14	0 18	0 11	40½
	9 10	0 14	0 06	0 12	40½
	10 0	0 14	0 08 E	0 12	40½
	11 0	0 14	0 51 W	0 12	40½
	12 0	0 14	0 30	0 12	40½
26th	A. M.				
	1 09	0 08	0 14	0 12	40
	2 4	0 11	0 11	0 20	40
	3 4	0 13	0 11	0 16	39
	3 59	0 17	0 09	0 13	39
	5 0	0 01	0 01	0 14	39
	6 02	Zero	0 06 E	0 09	39
	7 0	Zero	0 02 W	0 03	39½
	8 0	0 16 W	0 02	0 09 W	40
	10 3	1 55	1 18	2 22	40
	11 3	1 37	1 03	1 20	39½
	12 3	1 22	0 50	1 11	38
	P. M.				
	1 9	1 06	0 38	1 10	38
	2 15	1 06	0 42	.....	38
	3 0	0 48	0 21	.....	37
	4 0	0 15	0 08	0 06	36½
	5 5	0 17 E	0 08 E	0 20 E	36½
	6 5	0 17	0 26	0 17	36½
	7 0	0 09	0 10	0 17	34½
	8 5	0 09	0 11 W	0 17	34
	9 10	0 09	0 30	0 13	34
	10 5	0 09	0 30	0 19	34
	11 0	0 09	0 16 E	.....	31½
	11 57	0 09	0 16	.....	28½
27th	A. M.				
	1 0	0 48	0 38	0 52	27½
	2 0	0 54	0 41	0 58	27½
	3 0	0 15	0 09	0 19	27
	4 0	0 05	0 27 W	0 0	27

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Needle No. 3.	Temp.
1825.	A. M.				—
27th	h. m.	° ′	° ′	° ′	°
	5 5	0 02 E	0 26 W	0 10 E	26½
	6 0	0 13 W	0 29	0 15 W	27
	7 0	0 42	0 30	0 15	27
	8 0	0 37	0 18	0 11	27
	9 22	1 36	0 43	1 19	25½
	10 8	0 27	0 18	.....	25½
	11 7	0 48	0 39	.....	26
	11 57	0 19	0 08	....	27
	P. M.				
	1 02	0 52	0 54	0 46	28
	2 00	0 26	0 30	.....	28
	3 0	0 06	0 30 E	0 08 E	28
	4 5	0 08 E	0 17	0 13	27½
	5 5	0 08	0 17	0 13	26½
	6 27	0 08	0 17	0 13	27
	7 5	0 08	0 17	0 13	27
	8 2	0 23	0 18	0 17	27½
	9 11	0 40	0 27	0 20	28½
	9 57	0 56	0 32	0 56	29
	11 2	1 04	0 32	.....	30
	11 59	0 56	0 31	0 45	30½
28th	A. M.				
	1 0	0 39	0 06	0 34	31½
	2 0	0 45	0 27	0 18 W	31½
	3 0	0 03 W	0 01	0 27	32
	4 0	0 03	0 39	Zero	33½
	5 5	0 01	0 39	Zero	32
	6 0	0 03	0 35	0 01	33
	7 0	Zero	0 42	0 02 E	33
	8 0	0 11	0 04	0 16 W	32½
	9 5	0 25	0 14 W	0 09	32
	9 57	0 15	0 17	.....	30
	11 2	0 32	0 22	.....	30
	12 1	0 22	0 23	0 19	29½
	P. M.				
	1 7	0 19	0 14	0 17	28
	2 59	0 19	0 14	0 06	26
	4 2	0 08	0 03 E	.....	25
	5 1	0 09 E	0 17	.....	26
	6 5	0 10	0 21	0 05 E	26
	7 5	0 13	0 21	0 05	26
	8 6	0 04	0 17	0 08	26½
	9 4	0 26	0 14	0 32	28
	9 55	0 38	0 19	0 38	28
	11 10	0 42	0 19	.....	29½
	12 3	0 19	0 16	0 27	29
29th	A. M.				
	1 0	0 11	0 02	0 17	30
	2 0	0 11	0 07	0 16	30
	3 0	0 05	0 06	0 13	30
	4 4	0 01 W	0 06	0 01	30

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Needle No. 3.	Temp.
1825.	A. M.				—
29th	h. m.	° ′	° ′	° ′	°
	5 05	0 04 W	0 03 E	0 04 W	30½
	6 0	0 04	0 05	0 02	30½
	7 0	Zero	0 07	0 01	29½
	8 15	0 01	0 07	0 01	29
	9 7	0 49	0 20 W	0 35	28
	10 0	0 28	0 18	0 23	28
	11 0	0 28	0 26	0 17	27½
	11 59	0 36	0 22	0 24	27½
	P. M.				
	1 4	0 20 E	0 06 E	0 15	28
	2 6	0 16 W	0 39	0 07	28½
	3 2	0 03 E	0 02	0 11 E	29
	4 0	0 03	0 02	0 11	28½
	5 2	0 03	0 02	0 04	28½
	6 2	0 03	0 05	0 04	29
	7 0	0 08	0 05	0 04	29
	8 5	0 09	0 05	0 04	28½
	9 5	0 01	0 05	0 08	27½
	10 7	0 01	0 05	0 15	27½
	10 57	0 05	0 06	.....	27½
	12 0	0 05	0 04	.....	27
30th	A. M.				
	1 7	0 55	0 30	0 53	25½
	2 0	0 29	0 08	0 25	26½
	3 5	0 04	0 01 W	0 10	25½
	3 55	0 13	0 08	0 10	25½
	5 0	0 13	0 01	0 10	26
	6 0	0 07	0 01	0 02	27
	7 0	0 01	0 07	0 04	25½
	8 0	0 01	0 07	0 04	25
	11 55	0 24	0 28	0 10 W	25½
	P. M.				
	1 21	0 02 W	0 11	.....	26
	2 03	0 02	0 04	.....	26
	3 0	Zero	0 03	Zero	25½
	3 57	0 06 E	0 07 E	0 07 E	25½
	5 0	0 06	0 06	0 07	25½
	6 0	0 15	0 12	0 12	27
	7 0	0 13	0 21	0 07	28
	8 0	0 11	0 33	0 07	28
	9 5	0 11	1 02	0 09	29
	10 0	0 11	1 03	0 16	29½
	11 0	0 11	1 03	0 16	30½
	12 0	0 11	0 46	0 16	31
31st	A. M.				
	1 15	Zero	0 47	.....	30
	2 02	0 07	0 40		
	3 04	0 02	0 36		
	3 59	0 09	0 27	0 10	30
	5 0	0 05	0 24	0 05	30½
	6 0	0 05	0 23	0 04	30½

January.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Needle No. 3.	Temp.
1825.	A. M.				—
31st	h. m.	° ′	° ′	° ′	°
	7 0	0 04 W	0 07 E	0 04 W	30½
	8 0	0 14	0 03 W	0 10	30½
	P. M.				
	1 1	.....	0 03	0 10	31
	3 10	.....	0 02 E	0 05 E	33
	3 30	0 13 E	.....	.....	34½
	4 02	0 26	0 20	0 12	34
	5 7	0 27	0 17	0 04	35
	6 5	0 27	0 22	0 04	35
	7 5	0 27	0 06	0 04	35
	8 5	0 27	0 17	0 04	35½
	9 15	0 20	0 10	0 04	35
	10 6	0 18	0 10	0 04	34
	11 2	0 17	0 05	0 08	34
Feb.	12 1	0 22	0 05	0 11	34
1st	A. M.				
	1 11	0 20	0 10	0 08	33½
	1 57	0 20	0 10	0 08	34
	2 58	0 20	0 19	0 09	33½
	3 58	0 24	Zero	Zero	33
	5 7	0 26	0 02	Zero	33
	6 9	0 26	0 02 W	Zero	33
	7 5	0 08	0 02	0 05 W	33
	8 5	0 08 W	0 01	0 08	33½
	9 7	0 07 E	0 04	0 10	31½
	10 0	0 03 W	0 04	0 10	31½
	10 57	0 04	0 08	.....	31½
	11 57	0 15	0 13	.....	31½
	P. M.				
	1 2	0 06	0 08	.....	32½
	2 0	0 01 E	0 04	.....	33½
	3 1	0 02	0 10 E	.....	32
	4 1	0 19	0 18	.....	32½
	5 1	0 19	0 22	.....	32½
	6 1	0 19	0 19	.....	35
	7 1	0 19	0 19	.....	35
	8 1	0 19	0 19	.....	35
	8 57	0 01 W	0 09	.....	34½
	9 52	0 01	0 11	.....	34½
	10 59	0 01	0 17	.....	34½
	11 56	0 09 E	0 26	.....	34½
2d	A. M.				
	1 9	0 15	0 18	.....	36
	2 2	0 09	0 17	.....	36
	3 1	0 09	0 22	.....	36
	3 58	0 07	0 22	.....	36
	5 01	0 07	0 22	.....	36
	6 01	0 07	0 22	.....	36½
	7 2	0 09 W	0 06	.....	37
	8 1	0 09	Zero	.....	38
	9 12	0 11 E	Zero	.....	37

February.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
2d	h. m.	° ′	° ′	°
	10 4	0 06 E	0 09 W	37
	10 58	0 12 W	0 11	37½
	12 1	0 18	0 20	35½
	P. M.			
	1 06	0 04	0 14 E	38
	1 56	0 04	0 14	38½
	3 02	0 04	0 09	40
	4 02	0 04 E	0 32	40½
	5 06	0 04	0 06	39
	6 1	0 04	0 05 W	39
	7 1	0 04	0 12 E	39
	8 3	0 04	0 12	39
	9 6	0 05	0 30	39
	10 1	0 11	0 30	38
	11 1	Zero	0 18	38
	12 2	Zero	0 18	38
3d	A. M.			
	1 14	0 13	0 19	35
	2 2	0 13	0 16	37½
	3 2	0 11	0 06	37½
	3 57	0 03	0 03	39
	5 6	0 03	0 03	39
	6 1	0 03	Zero	38
	7 1	0 06 W	0 03 W	37½
	8 1	0 32	0 13	37
	10 5	0 18	0 08	36½
	11 2	0 29	0 13	36
	11 58	0 25	0 10	34½
	P. M.			
	1 0	0 18	0 10	25
	2 3	0 05 E	0 06	25½
	3 2	0 03	0 04 E	26
	4 0	0 07	Zero	26½
	9 3	0 05	Zero	26½
	10 1	0 05	Zero	25½
	11 1	0 05	Zero	25½
	12 1	0 05	Zero	26½
4th	A. M.			
	1 07	0 04	0 04 W	
	2 2	0 06	0 07	27
	3 2	0 06	0 19	27
	4 7	0 06	0 23	26½
	5 6	0 06	0 24	26
	6 2	0 06	0 24	25½
	7 5	0 06 W	0 33	26
	8 2	0 32	0 42	26
	9 17	0 29	0 42	25½
	9 57	0 18	0 38	25½
	11 2	0 10	0 31	26
	12 2	0 35	0 42	26½

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825	P. M.			—
4th	h. m.	° ′	° ′	°
	1 0	0 09 W	0 24 W	27
	1 58	0 06 E	0 31	27
	3 02	0 13	0 07	26
	4 02	0 17	0 02	23½
	5 7	0 17	0 04 E	20
	6 4	0 17	0 04	18
	7 1	0 18	0 05	20
	8 0	0 18	0 05	20
	9 15	0 11	0 04 W	20½
	10 3	0 04	0 12	20½
	11 2	0 15	0 03 E	22
	12 1	0 32	0 12	22½
5th	A. M.			
	1 2	0 37	0 07	36
	1 57	0 29	0 07	26½
	3 0	0 29	Zero	27
	3 58	0 05 W	0 10 W	26
	5 6	0 03 E	0 10	25
	6 3	0 03	0 10	26
	7 3	0 03	0 10	26
	8 3	0 03	0 10	26
	9 12	0 08 W	0 13	25
	9 57	0 19	0 27	24
	11 6	0 26	0 36	24
	12 0	0 05	0 36	23
	P. M.			
	1 6	0 10 E	0 26 E	24
	2 0	0 10	0 38	25
	3 2	0 13 W	0 02	24½
	3 58	0 15 E	0 05 W	24
	5 4	0 15	0 14	24½
	5 57	0 15	0 14	24½
	7 0	0 15	0 08	24½
	8 0	0 15	0 08	24½
	9 4	0 20	0 12	22½
	9 59	0 30	Zero	
	11 6	0 15	0 11	
	12 4	0 30	0 03	22
6th	A. M.			
	1 02	0 19	0 14	20½
	2 0	0 11	0 13	20½
	3 1	0 06	0 13	21½
	3 57	0 06	0 19	21½
	5 06	0 06	0 19	21½
	6 1	0 06	0 19	21½
	7 1	0 06	0 19	20½
	8 1	0 06	Zero.	21
	9 2	0 04	0 26	17½
	12 2	0 12 W	1 21	15
	P. M.			
	1 08	0 39	1 21	17

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	P. M.			—
6th	h. m.	° ′	° ′	°
	1 56	0 01 W	0 51 W	17
	3 9	0 19 E	0 22	16½
	4 1	0 12	0 03 E	16
	5 2	0 12	0 01	16
	6 1	0 09	0 06	16
	7 1	0 01	0 06	16
	8 1	0 01	0 11 W	16½
	9 9	0 11	0 11	16½
	10 1	0 11	0 04	16½
	11 1	0 11	0 03	16½
	12 1	0 11	0 03	16½
7th	A. M.			
	1 3	0 09	0 05	18
	1 57	0 06	Zero	19
	3 01	0 06	0 07	18½
	4 2	0 06	0 08	17½
	5 6	0 06	0 08	17½
	6 1	0 06	0 08	18½
	7 1	0 06	0 32	18½
	8 1	0 01 W	0 11	18½
	9 57	0 07	0 32	20
	11 10	0 07	0 41	21
	11 58	0 03	0 38	21
	P. M.			
	1 6	0 05 E	0 39	21
	2 0	0 05	0 43	22
	3 0	0 05 W	0 43	24
	4 0	0 08 E	0 36	24
	5 10	0 06	0 41	25
	5 56	0 06	0 41	25½
	7 2	0 08	0 01 E	26½
	8 2	0 04	0 01	27
	9 1	0 13	0 01	28
	10 1	0 13	0 03	28½
	11 1	0 13	0 03	28½
	12 1	0 19	0 03	28½
8th	A. M.			
	1 08	0 12	0 01	28
	2 0	0 12	0 07 W	28
	3 2	0 14	0 07	28
	3 58	0 07	0 07	28
	5 2	0 14	0 07	29
	6 2	0 02	0 29	30
	7 02	0 02	0 29	30
	7 56	0 02	0 39	30
	9 2	0 12 W	0 19	31
	10 2	0 19	0 21	31
	11 2	0 30	0 36	31
	11 58	0 14	0 25	31
	P. M.			
	1 16	0 07 E	0 20	33½

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	P. M.			—
8th	h. m.	° ′	° ′	°
	2 9	0 17 E	0 20 W	33½
	3 1	0 14	0 15	33½
	4 1	0 14	0 20	34
	5 1	0 11	0 13	34
	6 1	0 21	0 04	35
	7 2	0 18	0 06	35½
	8 2	0 26	0 06 E	35½
	9 2	0 25	Zero	35
	9 58	0 33	Zero	36
	11 1	0 39	0 21 W	36
	11 56	0 46	0 19	36
9th	A. M.			
	1 1	0 22	0 24 E	36½
	1 58	0 26	0 31	36½
	2 58	0 17	0 31	36
	3 56	0 17	0 28	36½
	5 2	0 11	0 26	36½
	6 2	0 04 W	Zero	36½
	7 2	0 07	Zero	36½
	8 2	0 11	0 03 W	36
	9 6	0 03	0 03	36
	9 56	0 08	0 39	36
	11 0	0 15	0 50	36
	11 58	0 14	0 49	36
	P. M.			
	1 6	0 03	0 40	36
	2 9	0 10 E	0 20	36½
	3 7	0 03 W	0 25	36
	4 2	0 05 E	0 14	36½
	5 2	0 12	0 11	36
	6	0 10	0 08	36½
	7 2	0 14	0 16	36
	7 58	0 18	0 11	36
	9 7	0 19	0 08	36½
	9 56	0 18	0 14	36½
	11 8	0 21	0 11	36½
	12 4	0 28	0 01 E	36½
10th	A. M.			
	1 5	0 40	0 07 W	36
	2 2	0 20	0 07	36
	3 2	0 10	0 07	36
	4 2	0 10	0 11	36½
	5 11	0 11	0 33	37
	6 1	0 11	0 20	36½
	6 58	0 06	0 53	36½
	7 56	0 09 W	0 42	36
	9 54	0 21	0 43	35½
	11	0 21	0 43	35½
	11 37	0 27	.....	35½
	11 58	0 18	0 43	35½

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	P. M.			—
10th	h. m.	° Zero	° ′ 0 38 W	° 35½
	1 1			
	2 6	0 09 E	0 33	35½
	5 9	0 10	0 33	34½
	5 58	0 10	0 17	34½
	6 58	0 10	0 11	34
	9 59	0 30	0 11	32½
	10 59	0 43	0 06	32
	11 59	0 17	0 06	31½
11th	A. M.			
	1 7	0 17	0 28	31½
	2 4	0 10	0 43	30½
	5 2	0 16	0 32	30
	5 59	0 01 W	0 44	28
	7 03	0 03	0 49	27½
	9 49	1 05	1 17	29
	10 20	.....	1 54	28½
	10 24	1 59	2 49	29
	10 43	1 17	2 10	28½
	10 59	0 59	1 57	29
	11 59	1 32	2 09	30½
	P. M.			
	1 1	3 34	2 29	30½
	1 29	3 39	2 43	31
	1 59	4 26	2 59	31
	2 12	3 40	3 33	31
	2 42	2 49	2 53	32
	5 16	0 29 E	0 29	33
	5 57	0 03 W	0 58	33
	7 02	0 03	0 43	33
	9 53	0 15 E	0 23	30
	10 58	0 19	0 09	29
	11 58	0 26	0 07	26½
12th	A. M.			
	0 58	1 27	0 02	24
	1 28	1 33	0 19 E	22½
	2 2	0 58	0 19	20
	3 2	0 41	0 16	21
	5 12	0 26 W	0 41 W	20
	6	0 39 E	0 16 E	19
	6 3	0 24 W	0 34 W	
	6 10	.....	0 04	20
	7 11	0 11 E	0 24	18
	9 53	0 57 W	0 59	15
	10 52	0 27	0 59	14
	11 15	0 59	1 17	14
	12 2	0 30	1 29	13
	P. M.			
	1 2	1 28	2 05	13
	1 22	2 46	2 14	13
	1 46	1 14	1 36	13
	2 8	3 14	1 37	12

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	P. M.			—
12th	h. m.	° ′	° ′	°
	2 28	1 31 W	1 37 W	11½
	5 01	0 44	1 22	10
	6 01	0 31	1 22	11
	7 1	0 31	1 22	10½
	9 58	0 39 E	0 49	10
	11 02	0 19	0 01	10
	11 58	1 47	0 32 E	10
13th	A. M.			
	1 11	1 13	0 32	11
	2 7	1 06	0 09	11
	5 01	0 40	0 18 W	12½
	6 01	0 12	0 11	13
	7 7	0 39 W	0 52	12
	12 2	0 45	1 13	14½
	P. M.			
	1 2	1 43 E	1 36	13½
	1 42	0 48	1 03	13
	2 12	2 42 W	1 51	14
	2 42	0 06	0 56	14
	5 3	0 17	0 53	17½
	5 59	0 06	0 39	18
	6 59	0 36	0 39	20
	10 6	0 09 E	0 03	24
	10 53	0 15	0 05	24
	12 4	0 44	0 19 E	24
14th	A. M.			
	1 1	1 43	0 34	24
	1 53	1 25	0 31	24
	2 40	0 43	0 08	24
	5 3	0 36	0 06 W	25
	5 59	0 30	0 22	24½
	6 59	0 04 W	0 26	23½
	10 1	1 55	1 28	25
	10 31	2 20	1 45	25
	11 1	2 20	1 45	24½
	11 31	2 36	2 37	24½
	12 1	1 53	2 51	24½
	P. M.			
	0 31	2 35	3 08	24½
	1 7	2 39	.....	25
	1 31	2 36	2 48	27
	2 1	2 36	2 58	25
	2 31	2 00	2 19	24½
	5 2	0 19 E	0 52	26½
	5 58	0 54	0 23	27
	7 6	0 03 W	0 24	28
	10 14	1 50 E	0 22 E	31
	10 44	2 51	1 51	31
	10 58	2 31	1 40	31
	11 9	2 21	1 40	31
	11 59	2 31	1 39	30½

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	A. M.			—
15th	h. m.	° ′	° ′	°
	1 6	2 31 E	3 34 E	32
	2 1	2 48	3 34	32
	3 1	2 28	3 34	32
	3 31	1 28	2 58	32
	5 6	0 05	1 42	28½
	5 57	0 03	1 32	28½
	6 57	1 25 W	Zero.	29
	9 51	1 56	0 38 W	30½
	10 16	1 56	0 42	30
	11 1	1 28	1 04	29½
	11 10	1 48	.....	..
	11 46	2 08	1 20	29
	11 56	2 08	2 36	29
	12 11	2 08	2 16	29
	P. M.			
	0 28	.....	3 03	27½
	1 0	2 24	.....	..
	1 26	2 14	2 52	27½
	2 4	1 33	2 03	28
	5 2	0 22	1 02	31
	6 1	0 01	0 27	30
	7 1	0 01	0 27	31
	10 17	1 18 E	0 02 E	31
	10 58	1 48	0 39	31
	11 59	2 04	0 39	31
16th	A. M.			
	1 5	3 04	1 21	31
	1 16	2 19	1 17	31
	1 42	1 50	1 06	31½
	2 17	1 46	1 14	32
	2 55	1 02	1 02	32
	5 1	0 15	0 22	34
	6 4	0 22 W	0 18 W	34
	7 01	0 12	0 17	34
	9 52	0 22	0 33	34
	10 22	0 21	0 40	33½
	11 7	0 24	0 31	33
	12 1	0 41	0 46	33
	P. M.			
	1 2	0 22	0 41	33
	2 0	0 43	1 11	33
	2 42	0 34	0 45	30½
	5 4	Zero.	0 24	29½
	6 1	Zero.	0 24	29
	7 01	0 06 E	0 28	29
	9 58	0 36	0 19	24½
	10 42	0 20	0 20	23½
	11 7	0 22	0 34	23½
	12 8	0 46	0 18	23

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	A. M.			—
17th	h. m.	° ′	° ′	°
	1 1	0 19 E	0 29 E	22
	2 0	0 43	0 08	21
	5 1	0 08	0 01 W	22
	5 58	0 08	0 04	22½
	7 0	0 01 W	0 04	22
	9 59	0 11	0 23	20½
	10 30	.....	0 37	19
	11 3	0 18		
	11 20	0 18	0 19 E	19
	11 30	.....	0 12	19
	11 57	0 36	0 12	19
	P. M.			
	0 30	1 03	1 01 W	16
	1 5	1 12	1 03	17
	1 28	1 13	1 03	18
	1 42	0 59	1 02	18
	2 11	1 14	1 06	17
	2 42	1 05	1 05	17½
	3 15	0 28	0 52	18½
	5 1	0 20	0 32	19
	6 0	0 05 E	0 43	29
	6 59	0 19	0 43	22½
	10 2	0 49	0 22	24½
	10 59	0 41	0 42	
	11 25	0 43	1 05	
	11 52	0 59	1 25	
	12 2	1 06	1 26	
18th	A. M.			
	0 19	1 15	1 33 E	25
	1 1	1 40	1 39	25
	1 29	1 40	1 39	25½
	2 01	0 43	1 34	25
	2 42	0 14	1 11	27
	4 59	0 24	1 23	28
	5 59	0 33 W	0 22	28½
	6 59	0 02 E	0 13	28½
	10 1	0 41 W	0 11	26½
	11 1	0 22	0 11	26
	12 1	0 11	0 32	26
	P. M.			
	1 1	0 23 E	0 01	25
	2 01	0 38	0 11	27
	5 53	0 10	0 12 W	28½
	6 7	0 05	0 12	28
	7 02	0 07	0 12	29
	9 59	0 21	0 12	30
	10 59	0 08	0 22	30½
	11 59	0 20	0 22	31
19th	A. M.			
	1 8	0 17	0 11	32½
	1 49	0 24	0 11	32½

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	A. M.			—
19th	h. m.	° ′	° ′	°
	2 7	0 44 E	0 11 W	32½
	2 30	0 24	0 11	32½
	3 01	0 24	0 11	31
	3 48	0 24	0 23	31
	5 1	0 06 W	0 16 E	30
	6 1	0 03 E	0 16	30
	7 1	0 01 W	0 11	30
	9 30	.....	0 24 W	30
	9 52	0 28	.....	31
	10 42	0 39	1 06	28
	10 59	0 16	0 31	26½
	11 29	0 59	1 12	26½
	11 59	0 45	1 21	26½
	P. M			
	0 58	0 50	1 13	26½
	1 31	0 58	0 52	27½
	2 2	1 04	1 07	28½
	2 32	1 14	1 17	29½
	3 1	0 55	1 01	31
	5 1	0 11	0 28	33
	6 01	0 03 E	0 28	35½
	7 01	0 03	0 28	33½
	7 41	0 36	0 08	35½
	9 56	0 10	0 02 E	34½
	10 59	0 26	0 03	35
	11 59	0 31	0 21	35½
20th	A. M.			
	1 1	0 28	0 03 W	35½
	1 31	0 24	0 11 E	35½
	2 2	0 54	0 24	36½
	2 32	0 21	0 11	34½
	3	0 25	0 11	34
	5 02	0 01	0 03 W	36
	6 01	0 04	0 22	36½
	7 01	0 04	0 22	36
	9 47	0 04 W	0 29	35
	10 2	0 09	0 28	35
	10 27	0 10	0 12	33
	11 4	1 05	0 42	31½
	11 32	1 09	1 14	32
	12 6	1 13	1 21	31½
	P. M.			
	0 18	1 30	1 24	30½
	0 59	0 59	1 16	29½
	1 31	1 06	1 22	31½
	1 41	0 23	1 20	32
	1 55	0 35	0 59	32½
	2 8	0 33	0 41	33
	2 31	1 07	1 24	33
	2 54	0 49	1 13	33
	3 08	0 46	0 59	33

February.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
20th	h. m.	° ′	° ′	°
	5 4	0 01 W	0 14 W	37½
	5 58	0 14 E	0 14	36
	7 3	0 14	0 03	38½
	9 7	0 21	0 05 E	37½
	10 2	0 28	0 17	37½
	11 5	0 15	0 12 W	37½
	11 58	0 15	0 12	37½
21st	A. M.			
	0 59	0 15	0 20	38
	2 6	0 09	0 20	37½
	5 4	0 31 W	0 32	39
	6 1	0 31	0 32	39
	7 02	0 12	0 01	39
	9 01	0 22	0 34	39
	9 32	0 15	0 34	39
	10 3	0 43	0 49	38½
	10 41	0 49	0 51	34
	10 59	0 24	0 42	32½
	11 28	0 20	0 24	25
	11 59	0 08	0 22	25
	P. M.			
	0 17	0 02	0 17	31
	0 58	0 10 E	0 07 E	31½
	1 26	0 21	0 06	30½
	1 52	0 27	0 01	31½
	2 22	0 24	0 27	
	2 38	0 19	0 02 W	32
	3 13	0 09	0 12	
	3 54	Zero	0 07	
	4 59	0 16	0 50	35
	5 59	0 29	0 02	36
	6 59	0 48	0 08 E	35½
	7 57	0 36	0 17	34
	8 58	0 46	0 22	33
	9 26	0 48	0 26	31
	10 1	0 35	0 16	32
	10 31	0 31	0 02 W	31½
	11 1	0 20	0 09	32
	12 5	0 49	0 14	31
22d	A. M.			
	1 1	0 51	0 37 E	28½
	2 0	0 48	0 37	28½
	5 9	0 05	0 02 W	28½
	6 4	0 30 W	0 42	28½
	7 9	0 55	0 58	28½
	7 52	0 49	1 00	28½
	9 31	0 17	0 23	25
	9 51	0 26	0 44	25
	10 49	0 14	1 04	24
	11 1	0 19	1 04	24
	11 14	0 30	0 47	23

February.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
22d	h. m.	° ′	° ′	°
	11 31	0 31 W	0 52 W	23
	11 44	0 23	0 41	23
	11 59	0 20	0 31	23
	P. M.			
	0 58	0 10 E	0 34	20½
	1 17	0 11	0 14	22
	1 58	0 40	0 29 E	23½
	2 13	0 35	0 31	24
	3 05	0 27	0 28	24½
	5 5	0 07 W	0 08	25½
	6 3	0 09 E	0 11	26½
	6 58	0 24	0 19	26½
	7 56	0 35	0 24	27
	9 51	0 38	0 06	27
	10 59	0 33	Zero	26½
	11 59	0 26	0 38	27
23d	A. M.			
	0 26	.....	0 17	31½
	1 06	0 28	0 08	31½
	1 29	0 01	0 11 W	32
	2 09	0 53	0 52 E	31½
	2 41	0 34	0 48	31½
	3 01	0 04 W	0 41	31½
	3 33	0 04	0 30	31½
	5 6	0 06 E	0 39	32
	6 1	0 06	0 10	31½
	6 59	0 58 W	0 54 W	30½
	9 57	0 57	1 09	29½
	10 26	0 31	1 00	29
	10 58	1 29	1 31	28½
	11 27	1 20	1 11	27½
	11 58	0 49	1 20	25
	P. M.			
	0 27	0 50	0 41	24½
	1 00	0 03	0 50	25
	1 27	0 25	0 20	25½
	2 01	0 17 E	0 03	22½
	5 08	0 02	0 06	28½
	6 01	0 12	0 16 E	28½
	7 04	0 19	0 06	28½
	9 59	0 27	0 37	30
	10 59	0 56	0 37	30½
	11 59	0 56	0 37	30½
24th	A. M.			
	1 06	0 27	0 42	26½
	1 25	0 11	0 16	26½
	2 7	0 11	0 14	26½
	3 2	0 05 W	0 07	26½
	5 6	0 01	0 06	27½
	6 1	0 17 E	0 09	28
	6 18	0 11 W	0 13 W	28

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	A. M.			—
24th	h. m.	° ′	° ′	°
	9 32	0 18 W	0 17 W	26½
	10 2	0 22	0 21	26
	10 22	0 15	0 20	26½
	10 52	0 14	0 20	26½
	11 19	0 10	0 14	27
	12 7	0 02	0 17	27
	P. M.			
	1 0	0 06 E	0 16	26½
	1 29	0 17	0 07	26½
	2 2	0 30	0 02 E	26
	5 7	0 05	0 15 W	26½
	5 58	0 05	0 15	26½
	6 59	0 06	0 21	27
	9 47	0 11	0 09	27½
	10 17	0 07	0 18	27½
	11 2	0 09	0 09	27
	12 1	0 09	0 02	27½
25th	A. M.			
	0 59	0 13	0 01	29
	2 4	Zero	0 23	30
	5 11	0 09	0 18	30½
	6 01	0 08 W	0 24	30½
	6 56	0 06 E	0 21	30½
	9 5	0 08 W	0 29	29
	9 32	0 01	0 31	29
	10 2	0 21	0 43	25
	10 32	0 10	0 39	24
	10 57	0 10	0 36	23
	11 32	0 05 E	0 22	23
	12 6	0 04 W	0 29	22
	P. M.			
	0 48	0 01	0 17	22
	1 18	0 16 E	0 39	22
	1 27	0 02 W	0 23	26
	1 34	0 31		
	1 52	0 03	0 31	23
	2 13	0 20	0 18	23½
	2 50	0 04 E	0 08	24
	5 2	0 01	0 34	31
	5 59	0 01	0 26	30
	6 59	0 08	0 26	30½
	9 6	0 11	0 13	29
	10 6	0 17	0 13	28
	11 5	0 13	0 14	28½
	12 3	0 05	0 15	28½
26th	A. M.			
	1 4	0 02	0 01 E	27
	1 32	0 01	0 03 W	26½
	2 12	0 03	0 11	26½
	2 55	0 09	0 01 E	26
	3 33	0 06	0 07 W	23½

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	A. M.			—
26th	h. m.	° ′	° ′	°
	5 11	0 02 E	0 19 W	23½
	6 01	0 04 W	0 49	22½
	6 59	0 10	0 49	21½
	10 2	0 25	0 43	18
	11 5	0 35	0 58	18
	12 3	0 17	0 51	17
	P. M.			
	1 02	0 38	1 00	16½
	2 01	0 34	0 51	16
	2 17	0 29	0 48	16
	5 06	0 09 E	0 44	13½
	6 02	0 04	0 16	12½
	7 02	0 06	0 19	11½
	9 51	0 05	0 02	10
	10 55	0 15	0 24 E	10
	12 01	0 38	0 21 W	11½
27th	A. M.			
	1 4	0 29	0 18	11
	1 58	0 10	0 22	11
	5 6	0 14 W	0 20	11
	6 2	Zero	0 04	12
	7 2	0 05	0 17	14
	10	0 27	0 21	9½
	10 30	0 09	0 21	9½
	11 2	0 17	0 20	9½
	11 37	0 18	0 19	9
	12 5	0 10	0 21	9
	P. M.			
	0 31	0 11	0 22	9
	1 0	0 11	0 24	9½
	2 0	0 16 E	0 22	8½
	3 0	0 16	0 14	7½
	5 2	0 05	0 07 E	13
	6 0	0 02	0 19	13
	7 8	0 05	0 19	13
	9 51	0 07	0 19	13½
	10 59	0 07	0 19	13½
	11 59	0 07	0 19	13½
28th	A. M.			
	1 06	0 03 W	0 18	14
	2 00	Zero	.....	13½
	2 24	0 06 E	0 18	14
	5 01	0 01 W	0 19	13½
	6 01	0 02 E	0 19	13½
	6 59	0 07	0 17	14
	9 38	0 16 W	0 08	14
	10 02	0 16	0 12	11½
	10 49	0 19	0 27	8
	11 22	0 11	0 22	8
	12 01	0 22	0 01	8

February.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	P. M.			—
28th	h. m.	° ′	° ′	°
	1 03	0 15 W	0 08 E	11
	2 02	0 10	0 16	11
	5 01	0 13 E	0 26	24½
	5 58	0 08	0 26	25½
	7 01	0 08	0 26	26½
	9 27	0 04	0 26	28½
	10 12	0 05	0 26	28½
	11 01	0 09	0 20	28½
March.	11 59	0 08	0 19	26
1st	A. M.			
	1 03	0 05	0 12	26
	2 03	0 10	0 20	24
	5 5	0 05	0 18	21½
	6 01	0 19 W	0 12	21½
	7 01	0 01	0 12	22½
	9 6	0 41	0 06	27
	9 32	1 01	0 04	26½
	10 05	1 34	0 10 W	26
	10 32	1 40	0 14	26½
	11 00	1 27	1 01	27
	11 29	1 11	0 34	28½
	12 2	0 41	0 03	29½
	P. M.			
	0 58	1 07	0 33	29½
	1 32	0 12	0 08 E	30
	2 07	0 18 E	0 18	30½
	4 59	0 41	0 59	33
	5 59	0 13	0 38	33
	6 59	0 13	0 38	33
	9 01	0 20	0 22	34
	10 01	0 23	0 39	37
	11 04	0 33	0 47	38
	12 07	0 15	0 41	40
2d	A. M.			
	1 02	0 20	0 37	39½
	1 52	0 46	1 14	39½
	2 24	0 24	0 39	39½
	3 01	Zero.	0 01	40
	5 04	0 11	0 18	40
	6 01	Zero.	0 16	40½
	7 01	0 28 W	0 13 W	41½
	10 02	0 43	0 19	31½
	10 32	0 37	0 11	30½
	11 01	0 32	0 10	30½
	11 32	0 40	0 14	31
	11 58	0 32	0 09	31½
	P. M.			
	0 32	0 49	0 18	32½
	1 02	0 37	0 10	34
	1 31	1 11	0 30	34
	1 46	0 53	0 08	35

March.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No. 1.	Needle No. 2.	
1825.	P. M.			—
2d	h. m.	° ′	° ′	°
	2 02	0 18 W	0 08 E	36
	5 06	0 17 E	0 38	35½
	6 01	0 25	0 42	35½
	7 02	0 09	0 29	36½
	9 54	0 16	0 29	38
	10 51	0 21	0 43	38½
	12 02	0 46	0 43	38½
3d	A. M.			
	1 5	0 12	0 35	40
	2 01	0 01	0 26	40
	5 07	0 01 W	0 17	38
	6 01	0 02	0 17	38
	7 03	0 02	0 16	36½
	9 49	0 06 E	0 41	29
	10 49	0 41 W	0 09 W	27
	11 12	1 16	0 51	26½
	11 23	2 03	1 40	26½
	11 42	1 09	1 20	26½
	11 57	0 40	0 50	26
	P. M.			
	1 1	Zero.	0 02	26
	1 26	0 27	0 12	26
	2 01	0 44	0 07	26
	2 29	0 04 E	0 17 E	26
	2 58	0 02	0 22	26
	5 1	0 18 W	0 07 W	25½
	6 1	0 02	0 21 E	25½
	6 58	0 28 E	0 24	25
	10 02	0 27	0 18	26½
	10 12	0 28	0 19	26½
	11 1	0 33	0 37	26½
	11 59	0 34	0 49	26½
4th	A. M.			
	1 02	Zero.	0 21	27½
	1 28	0 02 W	0 16	27½
	2 8	0 04	0 07	27½
	2 16	.....	0 27	27½
	3 0	0 01	.....	27
	5 6	0 03 E	0 27	29
	6 01	0 24	0 40	32½
	7 2	0 31 W	0 07	31
	9 32	0 29	0 02 W	27½
	10 1	0 54	0 20	21½
	10 29	0 37	0 07	20½
	10 57	0 50	0 17	25½
	11 37	1 01	0 30	21
	12 2	0 59	0 44	26
	P. M.			
	1 02	0 06	0 09 E	18
	1 27	0 34	0 14 W	19
	1 58	0 58	0 33	19

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			—
4th	h. m.	° ′	° ′	°
	2 27	0 20 W	0 08 W	19½
	3 2	0 11 E	0 17 E	22
	5 4	0 11	0 10	29½
	5 58	0 04	0 07	31
	7 01	0 18	0 08	31½
	9 32	1 49	1 16	31½
	10 01	1 04	0 50	31½
	10 28	1 53	0 57	32
	10 59	0 31	0 52	32
	11 27	0 16	0 29	33
	12 1	0 15	0 18	32
5th	A. M.			
	0 59	0 20	0 18	30½
	1 59	0 20	0 18	30
	2 13	0 20	0 31	29½
	5 5	0 03	0 23	27
	6 01	0 01 W	0 19	27
	7 01	0 22 E	0 25	27
	9 13	0 32 W	Zero.	26½
	10 01	0 40	0 08	25½
	10 31	0 53	0 04 W	25
	11 01	0 20	0 02	24
	12 03	Zero.	0 16 E	21½
	P. M.			
	0 52	0 30 E	0 06	17½
	1 31	0 30	0 49	17
	2 01	0 22	0 46	17
	2 28	0 13	0 51	18
	3 01	0 47	1 06	19½
	4 56	0 05	0 46	26½
	5 53	0 43	0 49	29
	6 52	0 16	0 36	31
	9 06	0 33	0 46	31
	9 56	0 33	0 41	31½
	10 33	0 33	0 47	31½
	11 1	0 24	0 47	31
	12 1	0 16	0 16	29
6th	A. M.			
	1 02	0 21	0 31	29
	1 42	0 13	0 43	29
	2 04	0 13	0 26	29½
	2 42	0 11	0 28	28½
	3 12	0 24	0 20	28
	5 13	0 21 W	0 21 W	24½
	6 6	0 32	0 21	23
	7 01	0 32	0 30	23
	9 54	0 24	0 29	21½
	10 11	0 19	0 23	21½
	10 31	0 39	0 26	22½
	10 53	0 35	0 21	23½
	11 17	0 19	0 13	24

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
6th	h. m.	° ′	° ′	°
	12 04	0 04 E	Zero.	25
	P. M.			
	1 02	0 26	0 21 E	26
	2 01	0 54	0 37	26½
	5 09	0 08	0 31	33½
	6 02	0 08	0 37	33½
	7 02	0 13	0 41	34½
	9 59	0 16	0 36	36
	10 59	0 46	0 56	36
	12	0 24	0 56	36½
7th	A. M.			
	1 04	0 11	0 39	36½
	1 58	Zero.	0 19	36½
	5 09	0 13 W	0 16	36
	6 01	0 06 E	0 08	36
	7 01	0 05 W	0 01	36
	9 47	0 15	0 09 W	34½
	10 22	0 21	0 27	25½
	10 43	Zero.	0 20	26
	11 6	0 17	0 11	20
	11 32	0 11	0 13	18
	12 01	0 12	0 02	25
	P. M.			
	0 57	0 08 E	0 09 E	21½
	1 30	0 20	0 17	21
	2 02	0 25	0 23	20½
	5 01	0 05	0 16	31½
	6 00	0 06	0 16	33
	6 58	0 10	0 16	32½
	9 59	0 09	0 16	33
	11 07	0 07	0 34	33½
	11 59	0 08	0 19	31
8th	A. M.			
	1 04	0 01	0 37	29½
	1 31	0 08	0 22	29½
	2 02	0 06	0 36	29½
	2 47	Zero.	0 44	29½
	5 03	0 05	0 28	28½
	5 58	0 08	0 28	27½
	7 00	0 09	0 28	28
	9 26	0 39 W	0 03 W	26
	10 02	0 15	0 09	26
	10 30	0 41	.....	24
	10 48	.....	0 21	25
	11 01	0 45	0 29	25
	11 39	0 51	0 30	24½
	11 59	0 49	0 33	24½
	12 13	0 44	0 28	24½
	P. M.			
	1 02	0 20	0 21	22
	2 02	0 18 E	0 08 E	20½

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2	Temp.	March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			—	1825.	P. M.			—
8th	h. m.	° ′	° ′	°	10th	h. m.	° ′	° ′	°
	5 05	0 16 E	0 19 E	27		7 01	0 04 E	0 31 E	30½
	6 00	0 15	0 16	28½		9 54	0 13	0 19	32½
	7 01	0 18	0 21	28½		10 56	0 13	0 19	32½
	9 31	0 34	0 38	30½		11 56	0 13	0 17	32
	10 02	0 35	0 51	30½	11th	A. M.			
	10 37	0 50	0 58	31½		1 6	0 09	0 18	33
	11 02	0 39	0 56	31		2 01	0 04	0 17	33
	11 42	0 45	0 48	31		5 01	0 05	0 26	33½
	12 01	0 45	0 56	31		6 04	0 19	0 31	33½
9th	A. M.					7 1	0 17	0 21	34
	1 02	0 36	0 57	30½		9 57	0 41 W	0 50 W	17
	2 06	0 27	0 36	31		10 15	0 41	0 50	16
	5 04	0 02	0 11	29½		10 32	0 47	0 50	13
	5 59	0 06 W	0 05	28½		10 55	1 11	0 57	14
	7 01	0 18	0 05 W	28		11 32	2 06	1 23	14½
	8 58	0 31	0 18	26		11 59	2 06	1 23	16
	9 58	0 40	0 19	25		P. M.			
	10 59	0 25	0 08	23		1 01	1 37	0 54	16
	12 4	0 11	0 03 E	22		1 31	1 54	1 02	14½
	P. M.					2 06	0 46	0 21	13½
	0 57	0 27 E	0 44	20½		5 01	0 24 E	0 29 E	11½
	1 29	0 20	0 36	22		6 01	0 24	0 14	23½
	2 04	0 05	0 28	22½		6 57	0 42	0 29	29
	2 41	0 06	0 39	23		9 56	0 44	0 53	32
	2 59	0 24	0 48	23		10 58	2 16	1 11	33
	5 03	0 27	0 42	26		11 0	1 14	2 16	33
	6 01	0 09	0 26	27		11 59	0 58	0 49	33
	7 01	0 09	0 23	27½	12th	A. M.			
	9 02	0 11	0 29	28		1 02	1 15	1 08	33
	10 02	0 13	0 29	28½		1 38	1 15	1 08	33
	11 01	0 13	0 29	29		2 02	1 15	1 11	33
	12 8	0 19	0 29	29½		2 27	1 16	1 11	32½
10th	A. M.					2 58	0 36	0 34	32
	1 4	0 08	0 26	29½		5 01	0 09	0 18	33
	1 37	0 04	0 18	29		6 01	0 08 W	0 02 W	33
	2 07	0 27	0 31	29		6 58	0 21 E	0 11 E	33
	2 42	0 20	0 26	29		9 32	1 06 W	0 31 W	19½
	5 5	0 23	0 32	29		10 02	0 35	0 20	19
	6 6	0 13	0 20	29		10 26	1 09	0 32	18
	6 15	.....	0 15	29		11 2	2 21	1 50	16½
	7 00	0 20	0 15	29½		11 31	1 58	1 31	14½
	10 5	1 09 W	0 46 W	21½		12 01	1 29	1 31	12
	10 31	0 05	0 44	21½		P. M.			
	11 3	0 52	0 37	17½		1 2	0 53	1 16	9½
	11 27	0 36	0 19	16½		2 5	0 14 E	0 09	11
	12 8	0 11	0 02 E	17		5 7	0 38	0 43 E	23½
	P. M.					6 01	0 38	0 59	27
	0 58	0 24 E	0 09	15½		7 02	0 10	0 39	29½
	2 5	.....	0 27	16		9 31	0 14	0 32	30½
	5 6	0 09 W	0 01	25		10 1	0 19	0 36	30½
	6 01	0 05	0 16	28½		10 31	0 27	0 36	30½

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M			—
12th	h. m.	° ′	° ′	°
	11 01	1 01 E	0 59 E	30½
	11 31	1 11	1 08	30½
	12 01	1 07	1 22	30½
13th	A. M.			
	0 57	0 33	0 36	32½
	2 6	0 16	0 28	32
	5 7	0 19	0 34	31½
	5 59	0 46 W	0 01 W	32
	7 4	0 18 E	0 28 E	32
	9 6	1 00 W	0 17 W	18
	9 33	0 44	0 14	17
	9 55	0 32	0 15	15
	10 32	1 23	0 56	14
	10 58	0 45	0 21	9
	11 32	0 34	0 49	6
	11 58	1 49	1 43	8
	P. M.			
	0 20	2 41	2 21	7
	0 47	0 10 E	0 03	10
	1 4	0 49 W	0 57	10½
	1 27	1 05	0 34	11
	1 57	2 19	1 24	10
	2 31	0 49 E	0 40 E	9½
	2 55	1 24 W	0 29 W	10½
	5 08	0 01	0 06 E	21
	6 4	0 08 E	0 21	26½
	7 01	0 05	0 11	28½
	8 59	0 15	0 16	31½
	10 04	0 15	0 14	31½
	11 03	0 24	0 19	31
	11 56	0 41	0 26	31
14th	A. M.			
	1 01	1 09	0 57	32½
	1 29	0 51	0 42	32
	2 01	1 03	0 49	32½
	2 27	0 58	0 47	32½
	2 55	0 46	0 49	32½
	5 11	0 20	0 09	33
	5 59	0 46	0 15	33
	6 57	0 31 W	0 31 W	33
	9 28	1 38	1 08	19
	10 4	1 48	1 19	19
	10 29	1 48	1 19	15½
	11 4	1 48	1 20	9½
	11 19	1 46	1 20	10½
	12 06	1 07	1 26	12
	P. M.			
	0 15	1 54	1 41	10
	0 30	3 11	2 37	8
	0 32	.....	3 04	8
	0 35	.....	2 39	14

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			—
14th	h. m.	° ′	° ′	°
	0 39	2 39 W	2 39 W	
	0 43	.....	2 26	
	0 48	.....	2 21	
	0 52	2 07	2 10	14
	1 02	.....	2 23	
	1 09	2 23	3 36	14
	1 16	2 40	2 37	
	1 54	3 34	2 44	
	2 2	3 32	2 44	
	2 11	2 55	2 44	
	2 59	2 00	1 48	14
	5 00	0 04 E	0 12	25
	6 00	0 11	0 01	24
	6 59	0 21	0 03	26½
	9 29	0 21	0 03 E	27
	10 29	0 23	0 03	31
	11 29	0 24	0 03	31
	11 59	0 26	0 03	31
15th	A. M.			
	1 01	0 22	0 09	32
	2 12	0 11	0 06	32
	5 06	0 09	0 16	32½
	6 01	Zero.	0 02 W	32
	7 00	0 15 W	0 02	32
	9 58	0 25	0 12	18½
	10 21	0 30	0 18	18½
	11 09	0 16	0 07	11
	11 35	0 11	0 06	10
	12 03	0 11	0 06	9
	P. M.			
	1 00	0 26	0 07	13½
	1 29	0 05 E	0 18	14
	1 53	0 08	0 06 E	14
	2 32	0 10	0 11	15
	4 30	.....	0 29 W	20
	4 40	0 44 W	0 08	19
	4 50	.....	0 14	19
	5 15	0 11	Zero	19
	5 30	Zero	0 01 E	20
	5 45	.....	0 23	21
	6 10	0 04	.....	23
	7 11	0 26 E	0 46	23
	9 04	0 20	0 23	25
	10 03	0 16	0 22	25
	11 01	0 14	0 23	25
	12 04	0 14	0 23	25
16th	A. M.			
	1 04	0 04	0 16	26
	1 31	0 04 W	0 08	27
	2 02	0 01 E	0 13	26½
	2 31	0 03	0 13	26½

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.	March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—	1825.	P. M.			—
16th	h. m.	° ′	° ′	°	17th	h. m.	° ′	° ′	°
	3 02	0 03 E	0 13 E	26		7 01	0 21 E	0 26 E	25
	5 05	0 09 W	0 13	26		9 22	0 35	0 36	27
	5 51	0 03 E	0 13	27		9 57	0 22	0 35	27
	6 59	0 18	0 08	27		10 24	0 30	0 35	27
	9 37	0 20 W	0 02	18		11 01	0 27	0 35	27
	10 07	0 33	0 14 W	18		11 56	0 30	0 35	27
	10 52	0 30	0 33	16	18th	A. M.			
	11 29	0 22	0 22	14½		1 01	0 24	0 35	27
	12 4	0 21	0 11	16½		1 25	0 24	0 28	27
	P. M.					2 02	0 21	0 26	26½
	0 38	0 39	0 26	21		2 34	0 06	0 19	26½
	1 02	0 56	0 37	21		3 01	0 01	0 18	26½
	1 33	0 57	0 43	21		5 6	0 14	0 11	26½
	2 06	1 01	0 53	20½		6 01	0 14	0 16	26½
	2 13	0 49	0 39	20		7 01	0 14 W	0 04 W	26½
	2 17	0 40	0 31	20		9 59	0 15	0 01	14½
	3 03	0 40	0 31	20		10 05	0 54	0 44	13
	4 03	0 15	0 15	21		10 33	0 59	0 50	11½
	5 07	0 17	0 03	22½		10 58	0 48	0 53	12
	6 01	0 15	Zero.	25½		11 24	0 33	0 52	13
	7 01	0 04 E	0 12 E	26½		11 31	0 29	0 26	12
	9 32	0 24	0 23	27½		11 57	0 29	0 26	
	10 01	0 21	0 26	27½		P. M.			
	10 32	0 11	0 18	27		0 35	0 59	0 53	13½
	11 01	0 15	0 21	26½		0 56	0 59	0 53	13½
	11 32	0 15	0 26	27		1 21	0 22	0 38	9
	12 01	0 18	0 26	27		1 27	.....	0 24	13
17th	A. M.					2 06	0 41	0 18	9½
	1 5	0 33	0 42	27		3 01	1 04	0 38	13½
	1 31	1 06	0 58	26½		3 11	1 04	0 34	14
	1 57	0 57	0 45	26		3 31	0 44	0 33	14
	2 30	.....	0 31	27½		5 5	0 01 E	0 18 E	16
	2 57	0 32	.....	25		6 02	0 23 W	0 09	21
	3 58	0 11	0 23	25½		7 02	0 01 E	0 28	23
	5 01	0 11	0 23	25½		9 02	0 24	0 32	25½
	6 01	0 11	0 22	26½		9 56	0 24	0 32	25½
	7 01	0 11 W	0 01 W	26½		11 6	1 40	1 11	
	9 28	0 30	0 12	23		11 9	.....	1 27	
	10 01	0 49	0 28	22½		11 10	.....	1 37	
	10 32	0 31	0 23	22		11 11	.....	1 46	
	11 03	0 22	0 20	22		11 13	2 16		
	12 06	0 02 E	0 02	22		11 17	.....	1 56	23
	P. M.					11 19	2 16	1 56	24½
	1 01	0 42 W	0 21	21½		11 58	1 22	1 19	23
	1 29	0 16	0 06 E	21	19th	A. M.			
	2 01	0 16	0 01	18½		1 02	2 08	2 13	23½
	2 29	0 19	0 02	19		1 20	2 08	1 59	23½
	3 00	0 55	0 14	20½		2 01	1 13	1 29	23½
	3 42	0 39	0 14	20½		3 2	1 36	1 31	23½
	5 01	0 24	0 03	22½		3 10	1 36	.....	23
	5 56	0 01	0 16	22½		5 04	0 31	0 51	24½

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
19th	h. m.	° ′	° ′	°
	6 09	0 19 W	Zero	26
	7 0	0 28	0 23 W	25½
	8 59	0 41	0 32	13½
	9 34	0 44	0 39	14½
	9 58	0 50	0 42	13½
	11 0	0 26	0 41	11½
	11 36	1 15	1 09	9
	12 11	2 36	1 46	12
	P. M.			
	0 29	2 49	2 08	13
	0 52	3 40	2 49	15
	1 8	4 20	3 24	15
	1 21	4 02	3 01	16
	1 43	3 04	2 43	14½
	2 01	3 00	2 32	14½
	2 31	2 59	2 32	16
	2 57	3 19	3 02	14
	3 13	2 20	2 43	15
	3 42	1 26	1 14	16½
	5 6	0 01	0 22	20½
	6 01	0 19	0 05	21
	7 01	0 23 E	1 03 E	21½
	9 4	2 16	1 53	21½
	10 01	2 08	1 58	21½
	10 16	2 28	2 02	21½
	11 3	1 51	1 53	21½
	12 0	1 17	1 09	21½
20th	A. M.			
	5 14	0 29	0 40	23½
	6 06	0 06	0 19	24
	7 02	0 14	Zero	23
	7 55	.....	0 22 W	23
	9 26	0 49 W	0 53	17
	9 59	1 03	1 07	15½
	10 31	0 40	0 44	16½
	11 1	1 39	1 20	15½
	11 31	2 25	1 57	11
	11 46	2 57	2 38	11
	12 01	2 54	2 34	12
	P. M.			
	0 16	1 39	2 01	13½
	0 47	1 19	1 34	15
	1 0	.....	0 44	15
	1 33	1 07	1 01	14½
	2 00	0 30	0 29	14
	2 27	0 49	0 42	15
	3 14	0 11	0 25	13½
	5 16	0 30	0 05	19
	6 02	0 30	0 04	23
	7 01	0 29	0 32	24
	9 30	0 11 E	0 36	24½

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			—
20th	h. m.	° ′	° ′	°
	10 06	0 06 E	0 08 W	24
	10 31	0 01	0 06	24
	11 01	0 01 W	0 16	24
	11 39	0 01	0 16	24
	12 04	0 03	.....	24
21st	A. M.			
	1 03	0 20 E	0 22 E	35
	2 05	0 25	0 33	25
	2 21	0 25	0 41	25
	3 03	1 07	0 56	25
	3 59	1 53	1 32	24½
	4 16	1 04	1 01	25
	5 14	0 51 W	0 08 W	24
	6 10	0 38 E	0 46 E	22½
	6 20	0 38	0 56	23
	7 01	0 14 W	0 19 W	22
	7 19	0 29	0 36	22
	7 56	1 31	1 21	21½
	9 00	0 08 E	0 17	21
	9 29	1 30 W	1 08	21
	9 59	1 02	0 42	21½
	10 28	0 41	0 34	22
	11 4	0 41	0 34	22
	11 28	0 46	0 11	18½
	12 0	0 10	0 08	19
	P. M.			
	1 01	0 12	0 03	19
	1 26	0 19	0 28	19
	2 4	1 32	0 42	19
	2 26	0 02 E	0 04	19
	3 07	0 12	0 06 E	19
	3 50	0 01 W	.....	18
	5 3	0 15 E	0 16	19
	5 56	0 15	0 18	22½
	6 56	0 31	0 38	25
	9 3	1 17	1 07	30
	10 1	1 17	1 07	30
	10 58	1 17	1 07	30½
	12 00	1 17	0 51	32
22d	A. M.			
	1 1	1 20	1 32	32
	1 32	1 07	1 13	32
	2 4	0 44	0 51	32
	2 55	1 01	1 26	32
	5 12	0 39 W	0 10	29
	6 01	0 44	0 33 W	30
	6 20	0 06 E		
	7 01	0 27	0 26 E	27½
	9 44	0 50 W	0 34 W	8½
	10 01	0 50	0 34	9
	10 06	0 35	.....	3

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
22d	h. m.	° ′	° ′	°
	11 09	.....	0 26 W	5½
	11 33	.....	0 50	5
	11 46	1 19 W	0 54	5
	12 02	0 54	0 37	5
	P. M.			
	1 19	0 06 E	0 04	5
	2 01	0 38	0 17 E	5
	3 01	0 51	0 27	5
	5 0	0 23 W	0 02 W	12½
	6 04	0 15	0 12 E	20
	7 00	0 06	0 06	25½
	9 30	0 21 E	0 22	29
	9 58	0 21	0 22	28
	10 58	0 34	0 31	30
	12 0	0 52	0 45	30½
23d	A. M.			
	0 31	0 47	0 35	31½
	1 03	0 36	0 35	31½
	2 2	0 44	0 56	32
	3 2	0 34	0 29	32
	5 04	0 05	0 28	31½
	6 0	0 15 W	0 11 W	31½
	7 01	0 21 E	0 06 E	28½
	8 56	0 12 W	0 22 W	17½
	9 31	0 19	0 24	12
	10 10	0 32	0 29	10½
	11 2	1 00	1 13	8
	12 4	1 43	1 24	5
	P. M.			
	0 29	1 32	1 22	5
	0 52	1 40	1 24	2½
	1 16	2 19	1 30	6½
	1 42	1 27	1 09	6½
	2 04	1 06	1 04	7
	2 47	0 42 E	0 40 E	11½
	3 50	0 16	0 22	9
	5 0	0 10	0 20	15
	6 1	0 02 W	0 17	22
	7 01	0 10 E	0 16	32
	9 05	0 21	0 23	30½
	9 44	0 27	0 31	31
	10 23	0 27	0 31	31
	11 5	0 27	0 31	31
	12 2	0 40	0 40	32
24th	A. M.			
	1 01	0 23	0 22	33
	1 31	0 31	0 56	33
	2 01	0 15	0 27	33½
	2 33	0 04	0 09	33½
	3 04	0 25	0 26	33½
	5 01	0 20	0 17	34

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
24th	h. m.	° ′	° ′	°
	6 01	0 16 W	0 09 W	34
	7 00	0 14 E	0 22 E	30½
	7 16	0 22 W	0 20 W	30
	9 26	1 06	1 01	16
	10 4	0 33	0 49	13
	10 30	0 43	0 54	12½
	11 03	0 39	0 19	12½
	11 31	0 17	0 13	11½
	12 01	0 09	0 04	10½
	P. M.			
	1 04	0 20 E	Zero	11
	2 01	0 31	0 09 E	8½
	2 58	0 31	0 09	8½
	5 01	0 30	0 09	15½
	6 01	0 30	0 25	21½
	7 01	0 26	0 38	27½
	7 31	0 21	0 38	28½
	8 01	0 01	0 38	28½
	9 30	0 09	0 28	32½
	10 01	0 04	0 22	32½
	10 31	0 11	0 32	33½
	11 16	0 02 W	0 29	33½
25th	A. M.			
	0 29	0 02	0 29	34½
	1 06	0 11 E	0 50	34½
	2 06	0 09	0 39	34½
	2 30	0 01 W		
	3 2	Zero	0 17	35½
	5 3	0 12	1 18	35½
	6 01	0 12	0 06	35½
	6 59	0 06 E	0 06	31½
	7 15	0 03 W	.....	30
	9 2	0 21	0 24 W	18
	10 2	0 31	0 31	20½
	11 5	0 33	0 31	17
	11 32	0 20	0 29	15
	12 4	0 15	0 13	16½
	P. M.			
	1 1	0 09 E	0 06 E	14½
	1 26	0 14	0 11	15
	2 3	0 38	0 46	9
	2 31	0 38	0 56	10
	3 01	0 31	1 01	11½
	5 01	0 14	0 47	20½
	6 01	0 14	0 47	22½
	7 04	0 14	0 47	27½
	9 13	0 04	0 34	32
	9 59	0 09	0 30	30
	11 00	0 17	0 34	30
	11 58	0 11	0 29	30

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
26th	h. m.	° ′	° ′	°
	1 01	0 04 E	0 26 E	29
	1 30	0 04	0 17	29
	2 04	0 04	0 29	28½
	2 34	0 14	0 29	28½
	3 11	0 13	0 37	28½
	5 04	0 01	0 20	28
	6 01	0 01	0 17	26
	7 02	0 01	0 14 W	26
	10 01	0 03 W	0 20	13
	10 31	0 34	0 28	16
	11 1	0 29	0 23	14
	11 55	0 15	0 18	11½
	P. M.			
	0 31	0 02	0 08	13½
	1 05	0 05 E	0 01	14½
	2 05	0 29	0 16 E	14½
	2 57	0 47	0 21	14
	5 06	Zero	0 04 W	18
	6 01	0 04 W	0 10 E	21
	7 03	0 01	0 16	22½
	9 03	0 13 E	0 28	23
	9 58	0 08	0 18	23
	10 58	0 41	0 34	23½
	12 01	0 29	0 29	24
27th	A. M.			
	1 05	0 29	0 29	24
	2 05	0 32	0 28	24
	3 05	0 32	0 38	23½
	5 06	0 05 W	0 04 W	23
	6 01	0 14	0 20	22½
	7 01	0 20	0 20	21
	9 17	0 06	0 13	15½
	9 33	0 23	0 17	14
	9 55	0 18	0 22	13
	11 00	0 39	0 39	8½
	12 10	0 31	0 25	6½
	P. M.			
	1 00	0 50	1 02	5
	1 27	0 32	0 24	7
	1 57	0 42	0 32	8
	2 29	0 50	0 40	9½
	3 01	0 19	0 21	8½
	5 6	0 21 E	0 20	14
	5 59	0 22	0 17 E	16
	7 01	0 21	0 17	19½
	9 01	0 21	0 13	22½
	9 58	0 27	0 19	22½
	10 56	0 42	0 35	24
	12 06	0 59	0 52	25

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
28th	h. m.	° ′	° ′	°
	1 04	0 32 E	0 56 E	26½
	1 31	0 26	0 26	26½
	2 0	0 01	0 26	27
	2 32	0 31	0 26	27
	3 05	0 36	0 26	27
	5 01	0 11	0 17	28
	6 7	0 11	0 11	28½
	7 01	0 11	0 06	21½
	9 29	0 18 W	0 03 W	8½
	10 3	0 30 E	0 16 E	9
	10 31	0 11 W	0 02	7½
	11 1	0 20	0 18 W	5
	11 33	0 40	0 21	4½
	12 01	0 36	0 08	5
	P. M.			
	1 10	0 44	0 25	9
	1 36	0 39	0 25	9
	2 05	0 47	0 25	10
	2 42	0 35	0 25	9½
	3 01	0 28	0 19	10
	5 03	Zero	0 01	14½
	6 04	Zero	0 01	18
	7 7	Zero	0 01	19
	9 31	0 11 E	0 12 E	22
	10 01	0 11	0 16	22
	10 31	0 06	0 31	23
	11 3	0 14	0 26	23½
	11 29	0 09	0 26	24
	12 01	0 01	0 06	24
29th	A. M.			
	0 58	0 17	0 22	25
	2 04	0 10	0 12	25
	3 01	0 07	0 12	26
	4 05	0 06	0 12	27
	5 04	0 05	0 12	26
	6 01	0 05	0 12	26
	7 04	0 07 W	0 08 W	22½
	9 01	0 47	0 36	14
	10 01	1 00	0 40	8
	10 36	.....	0 13	6½
	10 59	0 22		
	11 33	0 06 E	0 12 E	6½
	11 59	0 49	0 33	8
	P. M.			
	0 59	2 00	1 42	6½
	1 29	2 20	1 57	4½
	2 00	1 21	1 36	3½
	2 27	1 32 W	0 21 W	5
	3 1	1 23	0 33	6
	3 35	0 03 E	0 01 E	4½
	5 3	0 35	0 38	10

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			—
29th	h. m.	° ′	° ′	°
	6 5	0 20 E	0 31 E	16½
	7 4	0 20	0 31	22
	9 13	1 27	1 11	26
	10 4	0 34	0 37	27
	10 33	0 21	0 32	28
	10 37	.....	0 46	28
	10 57	0 36		
	12 04	0 49	0 46	27
30th	A. M.			
	1 01	0 05 W	0 04 W	25½
	1 36	0 15	0 04	26
	2 01	0 41 E	0 20 E	26
	2 31	0 51	0 36	26½
	3 07	0 37	0 47	28
	3 42	0 21	0 17	28
	5 03	2 03	1 21	29½
	6 01	0 16	0 13 W	30
	6 59	0 30 W	0 40	21
	9 59	0 45	1 12	9½
	10 29	1 15	1 05	6
	11 3	0 45	0 40	2
	11 57	0 34	0 35	3
	P. M.			
	1 04	1 16	1 07	2½
	2 01	0 52	0 46	1½
	3 11	0 23	0 03	2½
	3 31	0 03 E	0 02 E	4
	5 02	0 21	0 16	8½
	5 59	0 21	0 16	20
	7 04	0 05	0 16	24
	9 05	0 33	0 37	27½
	9 59	0 46	0 40	28½
	11 01	1 01	0 54	29
	12 01	1 14	1 07	29
31st	A. M.			
	1 04	0 51	1 09	31
	2 3	0 08	0 06	31
	3 4	0 08	0 06	31
	5 6	0 19 W	0 16	31
	6 01	0 26	0 08 W	30½
	7 01	0 20 E	0 11 E	29
	8 54	1 29 W	1 12 W	16½
	9 58	0 42	0 44	12
	10 33	1 13	1 08	12
	11 0	1 46	1 24	11½
	11 29	1 43	1 14	11½
	12 01	3 17	2 43	10
	P. M.			
	0 56	1 49	1 29	10
	1 29	2 00	1 23	12
	2 01	0 13 E	0 12	11

March.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			—
31st	h. m.	° ′	° ′	°
	2 30	0 10 W	0 07 W	10½
	3 01	0 04 E	0 02 E	11
	5 01	0 09	0 02	13½
	6 01	0 09	0 02	24
	7 02	.....	0 02	24
	7 20	0 04	.....	26
	8 57	0 26	0 34	30
	10 1	0 49	0 43	31
	10 58	0 51	0 46	31
April	12 2	0 35	0 35	32
1st	A. M.			
	1 4	0 17	0 09	32½
	1 30	0 20	0 58	31½
	2 01	0 55	0 36	31½
	2 31	0 01 W	0 28	31½
	3 06	0 58 E	1 00	32½
	3 39	1 11	1 29	32½
	3 59	0 55	1 09	32½
	5 04	0 55	1 10	33
	6 03	0 43 W	0 13 W	33
	7 5	0 15 E	0 02	30½
	9 30	2 31 W	1 22	10½
	10 01	2 04	1 33	9
	10 32	1 43	1 28	9
	11 01	1 14	0 57	7½
	11 26	0 39	0 23	6½
	12 0	0 50	0 44	8
	P. M.			
	0 57	2 14	1 40	9½
	1 30	1 33	1 13	9
	1 59	0 23 E	0 06 E	10½
	3 01	0 37 W	0 34	12½
	3 58	0 45 E	0 14	5½
	5 01	0 45	0 14	8½
	6 01	0 11	0 01 W	9½
	7 2	0 43	0 50 E	25
	9 30	1 05	0 56	30
	10 04	1 51	1 31	30
	10 42	1 04	0 59	30½
	11 4	1 45	2 23	30½
	11 29	1 53	2 23	31
	12 3	1 12	2 00	32
2d	A. M.			
	1 01	1 33	1 57	32½
	2 00	1 21	1 47	32½
	2 56	1 19	1 11	33½
	5 03	0 01	0 31	33½
	6 01	0 23 W	0 02	32½
	7 03	0 20 E	0 02	32½
	8 58	1 02 W	0 48 W	14½
	9 58	0 58	0 41	13

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
2d	h. m.	° ′	° ′	°
	10 29	1 09 W	0 49 W	12
	10 54	1 22	1 03	12
	11 30	0 39	0 30	15
	12 01	0 50	0 32	14½
	P. M.			
	0 56	1 00	0 33	12½
	1 26	0 05	0 06 E	15
	2 01	0 56 E	0 39	13
	2 33	0 06 W	0 19	19½
	3 01	0 13 E	0 26	14
	5 01	0 11 W	0 26	17
	6 03	0 14 E	0 26	21½
	7 01	0 59	0 27	26½
	9 06	0 37	0 36	27
	9 58	0 56	0 41	27½
	11 0	1 13	0 55	27½
	12 01	0 42	0 39	27½
3d	A. M.			
	1 3	0 27	0 57	27½
	1 33	0 44	0 56	27½
	2 2	0 16	0 50	28
	2 31	0 11	0 39	29
	3 06	0 33	0 24	28
	5 6	0 51	0 19 W	29
	6 5	0 18 W	0 42	26
	7 01	0 18	0 42	24½
	9 59	2 43	2 03	11½
	10 31	2 08	1 46	11½
	10 59	1 16	1 10	11½
	11 30	0 25	0 48	12
	11 58	0 30	0 50	10
	P. M.			
	0 33	0 10 E	0 14	10½
	0 58	0 28	0 11	7
	1 55	0 44	0 01 E	7
	3 04	0 44	0 23 W	7½
	5 07	0 19 W	0 11	10½
	6 01	0 19	Zero.	
	7 00	0 09 E	0 06 E	19
	9 4	0 20	0 01	24
	10 1	0 34	0 14	24
	11 01	0 40	0 17	25
	12 2	0 21	0 03	25
4th	A. M.			
	1 4	0 21	0 12	26½
	2 01	0 21	0 12	27
	3 3	0 21	0 12	27
	5 6	0 30	0 21	27
	6 0	0 30	0 16	25½
	7 0	0 12 W	0 32 W	22
	9 0	1 19	1 11	4½
	9 56	1 02	1 00	1

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			—
4th	h. m.	° ′	° ′	°
	10 28	1 10 W	1 08 W	1½
	11 3	1 29	1 46	3
	11 29	1 15	1 08	0½
	12 01	1 30	1 20	2½
	P. M.			
	1 0	0 38 E	0 36 E	3
	1 30	0 06	0 57	4
	2 0	1 40	1 28	6
	2 32	1 30	1 19	1½
	2 59	1 22	1 19	1
	3 29	1 00 W	0 08 W	0½
	3 57	0 23 E	0 46 E	0½
	5 01	0 08	0 22	2
	6 01	0 36	0 46	11
	7 3	0 06	0 36	19
	9 1	0 35	0 46	24
	10 1	1 17	1 05	27
	10 16	0 47	0 57	28
	10 56	0 18	0 06	28
	11 14	0 25	0 07	28
	11 56	0 25	0 23	29
5th	A. M.			
	0 58	0 12	0 21	29½
	2 01	0 06	0 16	30½
	2 58	0 03	0 17	31½
	5 5	0 03	0 17	31½
	5 59	0 03	0 17	31
	7 01	0 03	0 17	17
	9 33	0 52 W	0 40 W	4
	10 0	0 52	0 32	4½
	10 31	0 09	0 33	2½
	11 0	0 33	0 21	1½
	11 30	0 45	0 19	1½
	12 01	0 39	0 19	Zero
	P. M.			
	0 56	0 01	0 14	Zero
	1 13	0 21 E	0 06 E	1½
	1 51	0 28	0 43	1½
	2 16	0 16	0 41	2
	2 42	1 04 W	0 13 W	2
	3 01	0 38	0 12	2½
	3 11	0 18 E	0 18 E	3
	3 14	. . . . .	0 22	1½
	3 31	0 17	0 22	1
	3 51	0 10 W	0 10	1
	5 01	0 33 E	0 10	7
	6 01	0 33	0 47	13
	7 00	0 33	0 13	20
	9 30	Zero.	0 27	28½
	10 3	0 16	0 21	29½
	10 34	0 35	0 36	30
	11 0	0 31	0 47	30½

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			—
5th	h. m.	° ′	° ′	°
	11 31	0 44 E	1 00 E	30½
	12 01	1 30	1 48	30½
6th	A. M.			
	1 1	1 07	1 17	32
	1 52	0 46	1 13	32
	2 05	0 37	0 41	32
	3 01	0 28	0 32	33
	3 55	0 01 W	0 23	33
	5 01	1 01 E	0 58	32½
	5 57	0 07	0 37	30½
	7 0	0 21	0 18	22½
	7 55	Zero.	0 02	16½
	9 3	0 17 W	0 23 W	12
	10 01	1 30	1 28	9
	11 01	0 52	1 14	7½
	12 0	0 25	0 31	4½
	P. M.			
	1 0	0 32 E	0 09 E	Zero
	1 29	0 51	0 49	5½
	2 0	1 08	1 08	8
	3 0	1 08	1 11	8
	5 0	0 46	0 37	8
	6 4	0 01	0 12	14
	7 03	0 01	0 12	22
	9 7	0 01	0 20	28
	10 5	0 01	0 12 W	29
	11 1	0 01	0 06 E	29
	12 1	0 01	0 06	30
7th	A. M.			
	1 4	0 06	0 31	30
	1 31	0 06	0 21	30
	2 00	0 06	0 21	30
	2 26	0 11	0 27	30½
	3 4	0 07	0 23	30½
	5 01	0 40	0 31	30½
	6 01	0 58	0 37	29½
	7 01	0 04 W	0 03	20
	7 53	0 04	0 19	15
	8 58	0 09	0 14	10½
	9 56	1 01	0 09	5½
	10 31	1 04	0 01	5½
	10 59	1 10	0 09 W	5
	11 28	1 41	0 14	3½
	12 01	2 18	0 58	2½
	P. M.			
	1 10	1 34	1 06	5
	2 01	2 07	1 36	3½
	3 01	0 31	0 36	1
	5 01	0 29 E	0 18 E	5
	5 33	0 06 W	1 59	8½
	6 6	0 21 E	0 36	12
	6 33	0 01 W	0 36	14½

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			—
7th	h. m.	° ′	° ′	°
	7 06	0 04 W	0 04 W	17
	7 33	0 21 E	0 27 E	22
	8 58	0 16 W	0 21	25½
	9 56	0 11	0 27	26
	11 2	0 16	0 19	26
	12 4	1 17 E	1 20	27½
8th	A. M.			
	1 4	1 54	1 40	28
	2 4	1 54	1 40	27½
	3 3	0 38	1 08	27½
	5 4	0 25	0 29	25½
	6 0	1 01	0 36	21
	7 0	0 38	0 26	16½
	9 26	0 31 W	0 21 W	11
	10 7	0 46	0 26	8½
	10 12	.....	0 34	8
	10 31	0 41	0 24	7½
	11 8	1 26	1 11	7½
	11 33	0 45	0 34	7½
	12 03	0 48 E	2 12	8
	P. M.			
	1 0	1 11	2 21	6
	1 56	1 52	2 01	8
	3 01	2 37 W	1 46	9
	5 12	0 29	0 54	10
	5 59	0 29	0 34	12½
	7 4	1 00 E	0 23 E	15
	9 33	2 03	1 59	23
	10 1	1 53	2 16	23
	10 33	1 46	1 19	23½
	11 11	3 47	2 18	23½
	12 1	3 21	1 58	24
9th	A. M.			
	1 8	2 19	1 47	24
	2 2	1 27	1 17	24
	5 4	0 02	0 09	25
	6 03	0 14 W	0 08 W	21½
	7 01	0 29	0 27	16
	9 30	0 43	0 40	10
	10 1	0 20	0 23	10½
	10 31	1 34	1 24	7½
	11 0	2 20	1 44	9
	11 30	3 38	2 50	9½
	12 0	3 10	2 42	10
	P. M.			
	1 1	3 16	2 54	8½
	1 32	2 00	2 06	8
	2 06	0 36	1 14	8
	2 33	2 25	2 03	9½
	3 06	1 34	1 34	11
	3 51	1 53	1 41	13½

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	A. M.			∓
9th	h. m.	° ′	° ′	°
	5 03	0 02 W	0 49 W	—14
	6 01	0 02	0 49	—16½
	7 01	0 23 E	0 29	—18
	9 31	0 23	0 21	—20½
	10 01	0 41	0 04	—20½
	10 30	0 14	0 09	—20½
	11 03	0 23	0 20 E	—20½
	11 31	0 52	0 41	—20½
	12 01	1 01	1 01	—20
10th	A. M.			
	1 8	3 48	2 08	—20
	1 56	3 06	2 28	—20
	2 11	3 26	2 39	—19½
	2 56	4 11	3 04	—18
	3 51	1 43	1 33	—18
	5 3	0 34	0 56	—18
	6 01	0 18	0 44	—17
	7 04	0 01	1 02	—16
	9 03	1 13 W	0 07 W	—10½
	10 01	1 30	0 14	—10½
	11 1	1 00	0 05	—10
	12 4	0 19	0 23	— 9
	P. M.			
	0 52	0 17 E	Zero	— 7½
	1 29	0 07 W	0 12	— 8½
	2 01	1 22	0 51	— 8½
	2 31	0 04	0 14	— 8
	3 3	1 06	0 43	— 7½
	3 30	0 59	0 32	— 7½
	5 01	0 28 E	0 41 E	— 9
	6 03	0 01	0 21	— 9
	7 6	0 27	0 38	— 9
11th	A. M.			
	9 01	1 10 W	0 17 W	— 5
	9 54	1 18	0 34	— 2½
	10 59	0 43	0 05	— 1
	11 30	3 03		
	12 3	Zero	2 00	+ 0½
	P. M.			
	0 24	2 35	1 49	+ 0½
	1 01	4 22	3 22	+ 2
	1 32	4 18	3 09	+ 2
	2 3	4 14	2 44	+ 3
	3 01	2 40	2 39	+ 3
	5 06	0 04	1 14	+ 7
	6 02	0 18 E	0 36	+ 5
	7 03	0 03	0 31	+ 4
	7 30	0 03	.....	+ 4
	8 58	0 41	0 10	+ 2
	9 31	1 28	0 19 E	+ 2
	9 58	0 35	0 06	+ 2

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			∓
11th	h. m.	° ′	° ′	°
	11 1	1 17 E	0 11 E	+ 2
	12 1	2 07	0 41	+ 2½
12th	A. M.			
	1 03	1 27	0 31	+ 2½
	2 2	1 01	0 23	+ 2½
	3 1	1 22	0 40	+ 2
	5 6	0 01	0 32	+ 7½
	6 0	0 17	0 32	+ 8
	7 0	0 02	0 20	+ 9
	9 34	0 46 W	0 09 W	+12½
	10 12	0 57	0 31	+13½
	10 34	1 10	0 36	+13½
	11 2	1 29	0 41	+13½
	11 32	1 59	1 09	+13½
	12 01	0 14	1 09	+13½
	P. M.			
	1 6	2 06	1 20	+13½
	1 54	1 53	1 16	+13
	2 58	1 16	0 54	+13
	5 01	0 21	0 11	+ 9
	6 01	0 02	0 04	+ 9
	7 0	0 21 E	0 09 E	+ 7
	9 46	0 51	0 26	+ 6
	10 01	1 13	0 38	+ 5
	11 03	0 31	0 23	+ 4
	11 51	0 31	0 21	+ 3
13th	A. M.			
	1 01	0 57	0 36	+ 1½
	1 57	1 05	0 42	— 1½
	2 58	1 01	0 41	— 3½
	3 59	0 57	0 36	— 5½
	5 03	0 57	0 36	— 5
	6 02	1 14	0 49	— 3
	7 05	0 03	0 26	+ 2
	9 29	1 10 W	0 31 W	+ 1½
	9 57	1 21	0 49	+ 2
	10 30	2 20	0 58	+ 1
	11 1	1 45	0 53	+ 1
	11 30	1 45	0 53	+ 2
	12 1	1 50	0 59	+ 4½
	P. M.			
	0 58	1 23	1 02	+ 5½
	1 31	2 01	1 11	+ 3½
	2 01	1 55	1 11	Zero
	3 01	1 46	1 11	— 0½
	5 5	0 46	1 36 E	— 5
	6 01	0 18	0 02 W	— 6½
	7 03	0 18	0 02	— 8
	9 33	0 34 E	0 29 E	—10½
	10 01	0 08	0 22	—11
	10 30	0 08	0 22	—11

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 1.	Temp.
1825.	P. M.			∓
13th	h. m.	° ′	° ′	°
	11 01	0 08 E	0 18 E	—11
	11 31	0 30	0 18	—11
	12 04	0 30	0 18	—12
14th				
	1 7	0 50	0 27	—12½
	1 31	0 50	0 26	—13
	2 01	0 50	0 26	—13
	3 06	0 41	0 51	—13½
	4 56	0 04 W	0 43	—12
	5 56	0 04 E	0 31	— 9½
	6 57	0 02 W	0 22	— 4
	9 01	0 19	Zero	— 9
	9 59	0 45	0 20 W	— 8½
	10 31	0 45	0 20	— 8½
	11 00	0 45	0 32	— 7½
	11 32	1 15	.....	— 5½
	12 0	1 04	0 32	— 1
	P. M.			
	0 5	.....	0 49	— 5½
	0 30	.....	2 34	— 4
	0 43	1 55 E	1 49	— 3
	1 4	1 11 W	0 54	— 3½
	1 32	3 44	1 41	— 1½
	2 1	3 43	1 44	Zero
	2 29	2 30	1 41	Zero
	3 0	2 34	1 39	+ 1
	3 52	2 12	1 01	— 1
	5 02	0 21	0 28	+ 0½
	6 01	0 45	0 40	— 0½
	7 02	1 10 E	0 18 E	— 1
	9 01	2 23	1 08	—11
	10 3	3 46	1 56	—12½
	11 1	3 46	2 0	—13
	12 01	3 46	2 0	—13½
15th	A. M.			
	1 1	2 43	1 41	—14
	1 33	1 51	1 22	—14
	2 00	1 17	1 02	—14
	2 33	1 31	1 01	—14½
	3 00	2 04	1 12	—14½
	5 5	0 31	0 29	—14
	5 57	0 31	0 29	—14
	6 56	0 34 W	0 04 W	— 8½
	9 04	0 56	0 19	— 6
	10 2	1 12	0 32	— 2½
	10 59	1 49	0 45	+ 3
	11 56	1 16	0 38	— 2½
	P. M.			
	1 03	0 05 E	0 01 E	— 7
	1 31	0 49	0 14	— 7
	2 3	1 50	0 32	— 8

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No. 1.	Needle No. 2.	Temp.
1825.	P. M.			∓
15th	h. m.	° ′	° ′	°
	3 0	1 11 E	0 36 E	+ 1
	5 9	0 34 W	0 11	— 4
	5 56	0 56	0 01 W	— 4
	6 56	0 12	0 01	— 5½
	9 01	0 05	0 16	— 8
	10 11	0 17 E	0 09 E	— 9½
	11 01	0 06	0 04 W	—11
	12 04	0 14	0 09	—13
16th	A. M.			
	1 05	0 14	0 04 W	—13½
	1 31	0 07	0 25 E	—14½
	2 01	0 10 W	1 17 W	—15
	2 31	0 39	1 17	—15
	3 05	0 37 E	0 16 E	—15½
	5 5	0 21 W	0 49 W	—12
	6 00	1 17 E	0 09 E	— 6½
	7 00	1 26 W	1 00 W	— 3
	9 31	0 33	1 00	+13½
	10 6	0 36	1 00	+14½
	10 31	1 17	1 00	+14½
	11 3	0 27	0 38	+14½
	11 34	0 26	0 38	+15
	12 01	0 31	0 38	+15
	P. M.			
	1 01	0 04 E	0 18	+22½
	1 58	1 22	0 21 E	+23½
	2 27	2 04	1 36	+24½
	5 11	0 30 W	0 06	+16½
	6 0	0 30	0 04	+13
	7 0	0 26 E	0 38	+ 8
	9 26	0 28	0 38	+0½
	10 7	0 28	1 03	—6
	10 34	0 41	1 08	—6
	11 6	1 46	1 47	—6½
	11 54	1 04	1 28	—7
17th	A. M.			
	0 58	0 36	1 19	—6
	2 0	0 21	0 57	—7½
	3 01	0 15	0 49	—9
	5 08	0 01	0 39	—8½
	6 02	0 01	0 38	—0½
	7 10	0 03 W	0 24	+8
	9 32	0 49	Zero	+22½
	10 0	2 22	0 52	+23½
	10 31	1 40	0 34	+22
	11 1	2 23	0 54	+21½
	11 31	2 30	1 12	+23
	12 01	3 01	1 16	+28
	P. M.			
	0 57	2 29	0 52	+26½
	1 33	1 06 E	1 18	+24½

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	A. M.			∓
17th	h. m.	° ′	° ′	°
	2 06	0 06 E	1 03 E	+22½
	5 01	0 34 W	1 00	+17½
	6 01	0 03 E	1 01	+14
	7 03	0 03	1 01	+ 2
	9 30	0 01	1 18	— 6
	10 01	0 31	1 39	— 7
	10 33	0 37	1 39	— 7
	11 5	1 00	1 56	— 7½
	11 33	1 10	2 01	— 8
	12 5	2 25	3 01	— 8
18th	A. M.			
	1 4	0 53	2 11	— 8
	1 31	0 28	0 03	— 8½
	2 03	0 03	0 02 W	— 9½
	5 02	0 08	1 56 E	— 7
	5 28	0 02	1 49	— 6
	5 59	0 29 W	0 11 W	— 2
	7 6	1 05	0 55 E	+ 5
	8 01	0 49	0 54	+10½
	9 02	0 42	1 06	+13½
	9 31	0 57	0 47	+16
	10 04	0 47	0 59	+18
	10 31	1 49	0 23	+ 9
	11 01	1 34	0 39	+ 8½
	12 06	0 56	0 39	+13½
	P. M.			
	0 49	0 01	1 12	+20½
	1 0	.....	1 39	+21½
	1 30	0 19 E		
	1 59	1 07	2 16	+20½
	2 31	1 33	2 28	+18
	4 58	0 56	2 06	+13
	6 01	0 43	1 42	+ 9½
	7 01	0 33	1 42	+ 4½
	9 3	0 33	1 32	— 6½
	10 2	0 11	1 32	— 8
	11 3	0 11	1 32	— 8
	12 3	0 06	1 32	— 8½
19th	A. M.			
	0 59	0 02	1 22	— 9½
	1 32	0 10 W	1 20	— 9½
	2 01	0 11	1 16	— 9½
	2 30	0 11	1 11	— 9½
	3 2	0 10	1 11	— 9½
	5 01	0 05 E	0 58	— 7
	5 57	0 09 W	0 46	— 2½
	7 01	0 28 E	1 10	+ 1
	9 16	0 11 W	0 45	+ 6½
	9 58	0 42	0 26	+ 9
	11 2	0 09 E	1 01	+ 9½
	11 31	0 16	1 07	+10

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	A. M.			∓
19th	h. m.	° ′	° ′	°
	12 3	0 02 E	0 47 E	+11
	P. M.			
	1 2	0 13 W	0 47	+10
	1 31	1 04	0 01 W	+10
	2 04	0 19	0 12 E	+10½
	3 0	0 09	0 26	+10½
	5 5	0 01	0 34	+ 7½
	6 0	0 11	0 34	+ 4½
	7 01	0 11 E	0 56	+ 3
	9 04	0 07	1 02	— 3½
	9 58	0 07	0 50	— 3½
	10 59	0 26	1 17	— 3
	12 4	0 26	1 18	— 3
20th	A. M.			
	1 05	0 42	1 18	— 3
	1 31	0 57	1 29	— 3
	2 03	1 05	1 50	— 3½
	3 01	0 42	1 36	— 3½
	5 4	0 18 W	0 41	+ 0½
	6 0	0 17 E	1 09	+ 1½
	7 0	0 08	1 01	+ 3½
	9 22	0 52 W	0 06	+ 6
	10 6	0 51	0 06	+ 8
	10 30	1 06	0 07	+ 9
	10 58	0 59	0 07	+ 9
	11 30	0 40	0 16	+12
	11 51	1 19	0 02 W	+12
	12 9	0 50	0 02	+13½
	P. M.			
	0 57	0 50 E	1 18 E	+13½
	2 4	1 07	1 22	+10½
	3 01	0 27	0 48	+11
	3 55	0 04 W	0 51	+11½
	5 0	0 01	1 06	+12½
	6 01	0 [illegible]	1 36	+10½
	7 04	0 2 9	1 21	+ 7
	9 00	1 03	.....	+ 6
	9 20	.....	1 58	+ 5
	9 32	1 53	2 11	+ 6
	10 01	1 53	2 11	+ 6
	10 36	1 36	2 11	+ 6
	11 0	.....	1 57	+ 5
	11 53	0 58	1 41	+ 6
21st	A. M.			
	0 59	0 39	1 29	+ 5½
	2 01	0 06	1 17	+ 5½
	2 26	0 07 W	0 38	+ 4½
	5 05	0 07	0 38	+ 6
	5 30	0 06 E	0 38	+ 6
	6 3	0 06	0 38	+ 7
	7 2	0 06	0 46	+ 7½

pril.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.	April.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No.1.	Needle No.2.				Needle No.1.	Needle No.2.	
1825.	A. M.			∓	1825.	A. M.			∓
21st.	h. m.	° ′	° ′	°		h. m.	° ′	° ′	
	9 30	1 33 W	0 04 W	+12	22d	12 4	0 14 E	1 09 E	+ 2½
	10 4	1 16	0 02 E	+12½	23d	0 59	0 06 W	1 09	+ 2
	10 29	1 24	0 03 W	+12½		1 31	0 01	1 06	+ 2
	11 5	2 01	0 37	+14½		2 03	0 01	1 02	+ 2½
	11 30	1 56	0 37	+15		2 31	0 06 E	1 06	+ 3½
	12 5	2 46	0 48	+16½		3 04	0 03 W	1 06	+ 2½
	P. M.					4 57	0 34 E	1 15	+ 3
	0 50	1 53	.....	+22		6 01	0 18	0 53	+ 7
	1 12	2 03	0 46	+21		7 12	0 24 W	0 38	+10½
	1 29	1 21	0 02	+20½		9 01	0 31	0 29	+11
	2 09	1 30	0 08	+19½		10 04	1 32	0 06	+13½
	2 36	0 48 E	1 29	+19		10 31	1 40	0 02	+12½
	3 11	1 52 W	0 16	+17½		11 01	0 19	0 41	+12
	3 32	0 14	0 31 E	+14		11 32	0 27	0 42	+12
	5 06	0 33 E	1 15	+12½		12 01	0 42	0 37	+13
	6 04	0 29 W	0 49	+10		P. M.			
	7 04	0 33 E	1 18	+ 9		1 13	2 15	0 49 W	+ 9
	9 31	0 05	1 18	+ 4		2 4	2 15	0 50	+ 9½
	9 58	0 05	1 18	+ 3		2 35	1 20	0 28	+12½
	10 31	0 28	1 32	+ 3		3 02	0 51	0 12 E	+16
	11 0	0 20	1 32	+ 3½		5 11	0 01	0 06 W	+15½
	11 31	0 18	1 31	+ 2½		5 57	0 48	0 04	+11
	12 6	0 24	1 31	+ 2		7 00	0 20	0 41 E	+ 7½
22d	A. M.					9 01	1 40 E	2 04	+ 5½
	1 10	0 38	1 36	Zero		10 01	0 59	1 34	+ 5½
	2 01	0 38	1 36	— 1		11 02	0 49	1 26	+ 5½
	2 56	0 45	1 40	— 1		12 03	0 30	1 18	+ 5½
	3 48	0 17	1 31	— 2	24th	A. M.			
	4 58	0 42	1 42	— 2½		1 5	0 17	1 58	+ 4½
	6 01	0 24	1 25	+ 2		1 33	0 17	1 49	+ 4½
	7 03	0 16	1 21	+ 7		2 03	0 17	1 49	+ 4½
	7 31	0 06	1 10	+ 7½		2 34	0 17	1 49	+ 4
	8 59	0 10 W	0 55	+16		3 04	0 17		
	9 34	0 51	0 23	+18½		5 7	0 22	1 39	+ 2½
	10 01	1 31	0 12	+21½		6 0	0 17 W	1 09	+ 2
	10 31	1 52	0 18	+22		7 4	0 39	0 56	+ 2
	11 0	2 01	0 28	+25½		8 55	1 04	.....	+ 5
	11 30	2 54	1 17	+17		9 29	1 24	0 13	+ 5½
	12 0	3 15	1 20	+19½		9 46	0 53	0 21	+ 5½
	P. M.					10 6	0 53	0 21	+ 6½
	0 41	3 11	1 23	+25		10 31	0 53	0 21	+ 7½
	1 0	2 40	1 07	+24		11 01	0 29	0 33	+ 7½
	1 29	1 55	0 31	+21½		11 31	0 37	0 26	+ 8
	2 01	0 01 E	0 58	+22		12 01	0 05	0 49	+ 8
	3 0	1 46	1 40	+27		P. M.			
	5 1	0 52	1 16	+22		0 36	0 08 E	0 56	+ 9
	6 19	0 16	1 01	+19½		1 12	0 33	1 19	+ 8
	7 01	0 16	0 59	+15½		2 02	0 21	1 17	+ 7
	9 04	0 28	1 11	+ 2½		5 06	0 10 W	1 10	+ 3
	10 5	0 28	1 24	+ 1		6 00	0 33	0 42	+ 3½
	11 5	0 15	1 11	— 0½		7 01	0 02 E	1 01	+ 2½

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	A. M.			∓
24th	h. m.	° ′	° ′	°
	8 53	0 03 E		
	9 20	.....	1 14 E	+ 2
	10 1	0 03	1 14	+ 0½
	10 36	0 03	1 06	+ 0½
	11 1	0 03	1 06	+ 1
	11 33	0 03	1 06	+ 0½
	11 53	Zero	1 03	+ 0½
25th	A. M.			
	0 58	0 21	0 12	+ 0½
	2 03	0 37	1 18	+ 0½
	3 02	0 36	1 32	+ 0½
	4 06	0 17	1 22	+ 1
	5 4	0 17	1 22	+ 1½
	6 4	1 08	1 22	+ 1½
	7 6	1 08	1 22	+ 2
	9 41	0 30 W	0 50	+12½
	10 6	0 43	0 36	+14
	10 30	1 34	0 07	+13
	11 03	1 01	0 42	+13½
	11 34	1 40	0 29	+14
	12 1	1 49	0 29 W	+14½
	P. M.			
	0 53	1 58	0 34	+20½
	1 29	1 49	0 24	+19
	2 01	1 44	0 24	+18½
	2 26	1 41	0 19	+17½
	3 01	1 17	0 02	+13½
	3 26	1 09	1 01 E	+13
	3 51	0 10	0 38	+11½
	5 03	0 10	0 38	+10
	6 02	0 19 E	1 13	+ 6½
	7 02	0 44	1 32	+ 4½
	9 29	0 45	1 47	+ 3
	10 2	0 35	1 50	+ 3
	10 30	0 53	1 44	+ 2
	11 03	1 28	2 7	+ 1½
	11 32	2 03	2 18	+ 1½
	12 9	2 54	2 57	+ 2
26th	A. M.			
	1 4	2 41	3 07	+ 1
	1 30	2 33	3 02	Zero
	2 01	2 33	2 32	Zero
	3 01	0 31	1 28	Zero
	4 01	0 11	1 06	Zero
	5 01	0 37 W	0 51	Zero
	5 58	0 47	0 46	Zero
	7 02	0 09 E	1 08	Zero
	8 3	1 36 W	0 05 W	+ 2
	9 04	2 09	0 32	+ 5
	10 5	2 09	0 47	+ 7
	10 36	1 19	0 01 E	+17

April.	Mean Time of Observation.	D eflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	A. M.			∓
26th	h. m.	° ′	° ′	°
	11 5	0 34 W	0 07 E	+17
	11 34	0 34	0 33	+18½
	12 1	1 09 E	1 37	+12½
	P. M.			
	0 53	1 02 W	0 26	+ 8
	1 23	0 14	1 01	+ 8
	1 55	0 43 E	1 46	+ 7
	2 33	0 06	0 48	+ 6½
	5 01	0 08	1 02	+ 7
	5 58	0 08	1 02	+ 8½
	6 59	0 06 W	0 52	+ 3½
	7 59	0 04 E	1 07	+ 1
	9 02	0 04	1 07	— 1½
	10 03	0 24	1 19	— 3
	11 3	0 24	1 19	— 7
	12 1	0 04	1 19	— 7½
27th	A. M.			
	1 01	0 03	0 48	— 7
	1 30	0 03 W	1 11	— 7
	2 01	0 03	1 11	— 7
	2 31	0 02 E	1 11	— 7½
	5 7	0 23	1 14	— 3
	6 01	0 05 W	1 14	— 2½
	7 01	0 01	1 14	Zero
	8 01	1 13	0 08	+ 5½
	8 55	0 51	0 23	+ 6½
	9 58	1 14	0 09	+ 9½
	10 58	1 18	0 04	+14½
	12 2	1 05	0 09	+14
	P. M.			
	1 06	0 09 E	0 28	+16½
	2 05	0 06 W	1 01	+13½
	2 31	0 05 E	1 01	+14
	3 02	0 05	1 07	+15
	5 01	0 29 W	0 39	+ 8½
	6 01	0 05	0 54	+ 7
	7 01	0 09	0 58	+ 5½
	9 03	0 46 E	1 40	+ 2
	10 01	0 55	1 40	+ 1½
	11 4	1 20	1 56	+ 1
	12 01	2 01	2 19	+ 0½
28th	A. M.			
	1 6	1 53	2 07	Zero
	2 04	1 01	1 26	— 1
	3 01	0 29	1 27	+ 3
	5 0	0 38	1 36	+ 1½
	6 0	0 12	0 59	+ 4½
	7 3	0 03	0 49	+ 7
	9 25	1 01 W	0 08	+13
	10 1	1 01	0 08	+15½
	10 31	1 14	0 03	+17

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	A. M.			∓
28th	h. m.	° ′	° ′	°
	11 1	1 39 W	0 06 W	+18½
	11 29	1 25	0 01	+18
	12 01	0 54	0 18 E	+23
	P. M.			
	0 59	0 35	0 24	+23½
	2 4	0 59 E	1 26	+23
	5 0	0 03	1 20	+10½
	6 0	0 11 W	1 21	+ 8
	7 4	0 10	1 16	+ 5
	9 26	0 12 E	1 26	+ 0½
	10 1	0 12	1 26	— 1
	10 31	0 26	1 37	— 3
	11 01	0 24	1 41	— 3
	11 57	0 33	1 46	— 3½
29th	A. M.			
	0 58	0 18	1 38	— 5
	2 0	0 18	1 38	— 6
	3 4	0 18	1 38	— 6½
	5 7	0 06	1 12	— 2
	6 02	0 06	0 27	— 0½
	6 59	0 04 W	1 09	+ 5½
	9 29	0 40	0 49	+19
	10 0	0 49	0 39	+23
	10 29	0 20	0 46	+25½
	11 0	0 49	0 34	+28½
	11 31	0 14	1 01	+29½
	12 0	0 19	0 48	+29½
	P. M.			
	0 46	1 09 E	0 31	+31
	1 1	0 10	0 55	+25½
	1 26	1 02	1 48	+18
	2 13	2 21	2 35	+21½
	2 34	1 26	2 35	+19½
	3 19	1 08	2 16	+11½
	5 5	0 38	1 34	+ 9
	6 7	0 38	1 34	+6½
	7 2	0 38	1 34	+ 4
	9 28	0 28	1 39	Zero
	10 0	0 14	1 30	— 1
	10 30	0 08	1 36	— 1
	11 1	0 06	1 28	— 2
	11 29	0 18	2 07	— 2
	12 2	0 41	2 16	— 2
30th	A. M.			
	1 15	0 40	1 57	— 2
	2 2	0 40	1 57	— 2½
	3 01	0 32	1 46	— 2½
	3 52	1 25	2 28	— 1½
	4 57	0 03	1 22	Zero
	5 58	0 08 W	1 13	+ 1½
	7 02	0 57	0 41	+ 4½

April.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	A. M.			∓
30th	h. m.	° ′	° ′	°
	9 02	0 57 W	1 12 E	+15
	10 02	0 43	1 12	+19
	11 04	0 53	0 42	+20
	12 0	0 03	1 01	+18½
	P. M.			
	0 53	0 15	0 52	+17½
	1 27	1 21	0 30	+15
	2 03	0 50	0 38	+11½
	2 33	1 36 E	2 11	+ 9
	5 01	0 27	1 27	+12
	6 01	0 44	1 41	+ 7½
	7 03	1 05	1 58	+ 3
	9 04	0 38	1 43	— 0½
	10 1	1 21	2 13	— 1½
	11 3	1 48	2 26	— 2½
	12 01	2 30	3 08	— 3
May 1st	A. M.			
	1 01	0 47	2 10	— 3½
	1 32	0 46	1 37	— 3½
	2 02	0 01	1 22	— 3½
	2 30	0 07 W	1 18	— 3
	5 01	0 46 E	1 34	— 0½
	6 0	0 08	1 36	+ 3
	7 11	0 15	1 26	+ 8½
	9 01	0 43 W	0 37	+11
	10 01	0 45	0 36	+11½
	11 01	1 00	0 23	+12
	11 31	1 27	0 02	+13
	12 0	0 18	0 14 W	+14
	P. M.			
	1 04	1 01	0 13 E	+21½
	1 30	0 25	0 33	+25
	2 01	0 37 E	1 13	+27
	2 32	0 37	1 13	+29
	3 3	0 10	1 13	+28½
	5 7	0 15	1 17	+13
	6 01	0 04 W	1 26	+ 8½
	6 54	0 37 E	1 29	+ 8
	9 0	0 15	1 37	+ 3
	10 01	0 21	1 41	+ 3
	11 00	0 24	1 40	+ 3½
	11 31	0 17	1 31	+ 3½
	11 58	0 17	1 31	+ 3½
2d	A. M.			
	1 03	0 17	1 31	+ 2
	1 32	0 17	1 31	+ 2
	2 01	0 17	1 31	+ 2
	2 29	0 17	1 31	+ 1½
	3 3	0 17	1 31	+ 3
	5 5	0 01	0 57	+ 5½
	6 02	0 24	1 05	+ 9½

May.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No.1.	Needle No.2.	
1825.	A. M.			∓
2d	h. m.	° ′	° ′	°
	7 0	0 30 E	1 02 E	+13
	9 31	0 03 W	0 28	+26
	10 02	0 19	0 12	+31
	10 33	0 06	0 23	+23½
	11 11	0 33	0 17	+27
	11 31	0 11	0 23	+24½
	12 13	0 08 E	0 46	+23
	P. M.			
	0 38	0 15 W	0 36	+23½
	1 16	0 34	0 22	+23
	1 31	0 46	0 01 W	+22½
	2 2	1 12	0 16	+23
	2 31	0 29	0 12 E	+18
	5 0	0 13 E	0 46	+14
	5 57	Zero	0 42	+10½
	7 03	0 06 W	0 56	+ 7
	9 29	0 04 E	0 59	+ 3½
	10 01	0 23	0 48	+ 3½
	10 31	0 08	0 47	+ 3
	11 11	0 06	0 47	+ 3
	11 53	0 33	1 08	+ 3
3d	A. M.			
	0 59	0 22	1 00	+ 3
	2 01	0 11	0 46	+ 3
	2 31	0 01 W	0 32	+ 3
	5 06	0 08	0 25	+ 3
	6 01	0 15	0 22	+ 4
	7 4	0 15	0 26	+ 4
	9 31	1 11	0 11 W	+ 7½
	10 01	0 29 E	0 01	+ 7½
	10 32	0 09	0 42	+ 7½
	11 5	0 09 W	0 36	+ 8
	11 31	0 04 E	0 26	+ 8½
	12 1	0 24	0 36	+ 9½
	P. M.			+
	0 52	1 20	.....	....
	1 17	0 39	0 23	+10½
	1 51	0 55	1 08	+10½
	2 32	0 15	0 18	+10½
	5 08	0 15	0 18	+ 7½
	6 01	0 15	0 18	+ 7
	7 03	0 15	0 18	+ 7
	9 31	0 25	0 59	+ 3½
	10 01	0 27	1 03	+ 3
	10 31	0 40	1 08	+ 2½
	11 01	0 26	1 09	+ 2½
	11 31	0 44	1 20	+ 2½
	12 01	0 31	1 11	+ 2½
4th	A. M.			
	0 55	0 51	.....	+ 3
	1 15	Zero	1 11 E	+ 1½

May.	Mean Time of Observation.	Deflections from the line of Zero.		Temp.
		Needle No.1.	Needle No.2	
1825.	A. M.			∓
4th.	h. m.	° ′	° ′	°
	1 36	0 51 E	1 21 E	+ 2
	2 08	0 36	1 31	+ 2
	2 31	0 36	1 31	+ 2
	4 53	0 07	1 20	+ 0½
	6 01	0 24 W	0 56	+ 0½
	7 02	0 42	0 24	+ 0½
	9 4	0 09 E	0 52	+ 7½
	9 32	0 09	0 52	+ 9½
	10 1	0 53 W	0 52	+13
	10 31	0 53	0 33	+12
	11 04	0 29	0 33	+13½
	11 31	1 51	0 02	+13½
	12 0	3 51	2 10 W	+12
	P. M.			
	0 41	2 00	0 56	+15
	1 08	6 04	4 24	+13½
	1 21	5 19	4 00	+12½
	1 31	3 21	3 24	+14
	1 43	2 14	2 21	+14
	2 01	2 10	2 14	+15
	2 31	2 54	2 41	+15
	3 04	1 27	1 41	+15
	5 09	0 56 E	0 07	+19
	5 31	1 38	0 46 E	+20½
	6 01	1 21	0 36	+17
	7 02	1 02	0 21	+15
	9 03	1 02	0 21	+ 3
	10 0	1 46	0 40	— 1½
	11 3	1 46	0 40	Zero
	12 01	0 52	0 28	3½
5th.	A. M.			
	1 1	1 17	0 39	— 4
	1 31	1 17	0 39	— 4
	2 0	1 03	0 39	— 4½
	2 31	1 14	0 41	— 4½
	3 05	0 50	0 31	— 5
	4 59	0 30	0 03 W	+ 5½
	6 01	0 14 W	0 21	+ 9
	6 51	0 49	0 54	+10½
	8 58	2 34	1 46	+22
	10 0	5 00	3 24	+20½
	10 31	4 30	3 10	+22½
	10 59	3 00	2 08	+22
	12 1	3 02	2 24	+23½
	P. M.			
	0 31	1 10	0 49	+21½
	1 4	5 00	3 36	+27
	1 31	3 24	2 02	+22
	2 01	5 04	3 22	+24
	2 31	3 47	2 34	+28½
	3 4	4 24	3 04	+29½

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	P. M.			+
5th.	h. m.	° ′	° ′	°
	5 3	1 58 W	1 11 W	23½
	6 02	0 06 E	0 23 E	14
	7 02	0 06	0 17	11½
	9 01	1 19	1 16	4½
	10 01	1 44	1 30	1
	11 01	1 6	1 00	0½
	12 01	1 41	1 21	0½
6th.	A. M			
	1 3	1 41	1 21	3½
	1 31	1 27	0 56	1½
	2 01	0 19	0 56	2
	2 31	1 15	1 06	4
	3 01	1 09	0 46	4
	5 01	0 30 W	0 41 W	6½
	6 02	0 47 E	0 08 E	10½
	7 5	0 30	0 16	13
	9 21	0 25 W	0 38 W	19½
	9 59	0 59	0 50	20½
	10 31	3 19	2 20	23
	11 1	2 57	2 20	21
	11 31	3 52	2 34	20½
	12 01	3 19	2 34	21
	P. M			
	1 0	4 08	3 05	29½
	2 01	0 56	1 04	28
	3 01	2 45	2 03	32½
	4 56	1 01 E	0 51 E	29½
	6 03	0 07	0 16	23½
	7 5	0 21	0 29	20½
	9 31	2 45	2 25	10
	10 01	2 45	2 28	10
	10 30	2 01	2 38	10
	11 00	2 01	2 26	9
	11 53	1 38	2 26	8
7th.	A. M.			
	1 0	1 21	2 12	5½
	2 01	0 43	2 04	5½
	5 5	0 43	1 28	11
	6 2	0 05	1 18	12
	7 4	0 27	1 31	13
	9 21	1 04 W	0 26	15
	10 0	1 21	1 17	20½
	10 31	2 34	2 21 W	23
	11 5	2 59	1 59	22½
	11 33	2 27	1 44	22
	12 01	4 01	2 38	22½
	P. M.			
	1 1	4 25	3 01	23
	1 29	4 15	3 21	22
	2 01	3 39	3 09	26½
	2 31	3 05	2 41	29½

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	P. M.			+
7th.	h. m.	° ′	° ′	°
	2 59	1 04 W	1 04 W	30
	5 05	0 39	0 47	17½
	5 59	0 16 E	0 04	18½
	7 02	0 53	0 06 E	17½
	9 30	1 31	0 46	13½
	10 01	1 51	0 51	13½
	10 31	2 01	1 17	12½
	11 05	2 19	1 32	11½
	11 30	1 58	1 27	11½
	12 01	2 07	1 37	11½
8th.	A. M.			
	0 52	2 41	.....	11
	1 10	.....	1 54	11
	1 31	2 25	1 07	11½
	2 10	3 08	2 03	12
	2 41	2 24	1 43	12
	4 58	0 32	0 21	12
	6 01	0 51 W	0 20 W	12½
	7 01	0 55 E	0 55 E	16½
	9 4	0 36 W	0 24 W	22½
	9 32	2 03	1 09	22½
	10 01	2 11	1 18	22½
	11 04	3 04	1 41	25½
	11 31	3 12	1 53	25½
	12 02	3 36	2 06	25½
	P. M.			
	0 51	1 44 E	1 03 E	25½
	1 29	3 57 W	2 29 W	24
	2 00	0 40	0 29	23
	2 32	0 40	0 21	24
	3 03	0 19	0 03	25½
	5 01	0 01 E	0 16 E	21
	6 03	0 28	0 38	18½
	7 01	0 16	0 23	16
	9 03	0 16	0 23	16
	10 02	0 16	0 23	14½
	11 01	0 51	0 23	12½
	12 0	2 00	1 21	11
9th.	A. M.			
	0 51	1 43	1 48	11
	1 30	1 39	1 37	11
	2 0	2 24	2 16	11½
	2 31	2 19	2 11	11½
	3 5	1 19	1 49	12
	5 5	1 13	1 16	15½
	6 15	0 12 W	0 58	17
	7 01	0 25	0 41	17½
	8 58	1 11	0 09	21
	10 1	1 45	0 16 W	20½
	11 1	2 31	0 48	24
	12 1	1 38	Zero.	25

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	P. M.			+
9th.	h. m.	° ′	° ′	°
	1 2	3 55 W	1 32 W	28½
	1 31	3 30	1 32	28
	2 2	3 01	1 11	26
	2 32	3 01	1 27	26½
	3 01	3 01	1 27	26½
	5 03	0 45 E	0 31 E	29½
	5 52	0 01 W	0 31	27½
	6 59	0 52 E	1 27	26
	9 1	2 17	2 01	19
	10 1	1 52	1 40	17
	11 1	2 21	2 21	14½
	12 1	1 30	1 57	13½
10th	A. M.			
	1 4	1 30	1 57	12
	2 01	1 49	2 31	11
	2 31	2 49	2 51	11
	3 04	2 49	2 51	13
	5 0	0 30	1 28	17
	6 0	0 19 W	1 07	17
	7 3	0 24	0 59	18
	9 31	0 45	0 26	21½
	10 0	0 18	0 47	19
	10 31	1 34	0 03	19
	11 1	2 01	0 25 W	21
	11 31	2 5	0 25	21
	11 59	2 24	0 44	20
	P. M.			
	1 0	3 07	1 01	18
	2 1	2 45	0 47	17½
	3 1	2 25	0 47	18
	5 0	0 30	0 41 E	12½
	6 5	1 19	0 29	8½
	7 03	0 19	1 07	6
	9 36	0 04 E	1 14	4
	10 6	0 06	1 17	3½
	10 30	0 16	1 17	3½
	11 6	0 16	1 17	3½
	11 31	0 31	1 22	4½
	11 53	0 31	1 22	4½
11th	A. M.			
	1 01	0 43	1 36	3½
	2 4	0 52	1 42	3
	2 48	0 35	1 25	3
	5 3	1 06	1 25	6½
	6 01	1 11	1 34	9
	6 32	0 26	1 17	9
	7 3	0 10 W	0 42	9½
	9 29	1 39	0 07 W	12
	10 0	1 05	0 08 E	10½
	10 31	0 44	0 20	13
	11 3	1 44	0 01 W	14

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	A. M.			+
11th	h. m.	° ′	° ′	°
	11 30	1 12 W	0 01 W	13½
	12 4	0 01 E	0 40 E	11½
	P. M.			
	0 57	1 29 W	0 51 W	9
	1 31	0 09	0 04	9
	2 01	0 49	0 20	9
	2 36	1 04	0 04	8½
	5 4	1 40	0 04	7½
	6 2	0 03 E	0 36 E	7
	7 01	0 03	0 36	7
	9 30	1 7	1 16	5½
	10 1	1 17	1 21	5½
	10 31	1 15	1 17	4½
	11 7	1 06	1 32	4½
	11 31	1 21	1 36	4
	12 1	1 41	1 52	4
12th	A. M.			
	1 0	2 26	1 52	4
	1 40	1 31	1 46	3½
	2 05	0 46	1 21	3½
	2 33	0 05 W	1 02	3½
	5 03	0 05	0 59	5½
	6 5	0 19	0 37	6½
	7 01	0 02 E	0 52	11½
	9 03	0 06	0 19	15½
	9 30	0 29 W	0 19	14
	10 01	0 46	0 19	14½
	10 31	0 46	Zero	15
	11 3	1 19	0 09 W	14½
	11 59	1 53	0 09	17
	P. M.			
	0 39	2 20	0 51	18
	1 5	3 34	1 01	15½
	1 31	3 07	1 12	14½
	2 2	1 29	0 23	14½
	2 31	1 31	0 27	14
	3 0	1 31	0 24	13½
	5 03	0 23	0 26 E	13½
	6 5	0 03	0 41	11½
	7 01	0 24 E	0 51	10
	9 03	0 24	0 51	11
	10 1	0 24	1 22	8
	11 4	1 09	1 22	7
	12 0	1 37	1 38	6
13th	A. M.			
	0 59	1 58	2 06	6½
	1 30	0 55	1 37	5½
	2 01	1 07	1 37	5½
	2 30	0 41	1 22	5½
	3 4	0 36	1 16	6
	5 2	0 55	0 41	6

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No.2.	Temp.
1825.	A. M.			+
13th	h. m.	° ′	° ′	°
	6 01	0 11 W	0 32 E	9½
	7 6	0 20	0 26	11
	9 01	0 58 E	1 02	14½
	10 5	0 13 W	0 39	17
	11 3	1 38	0 46 W	21½
	11 31	Zero	0 19 E	21
	12 1	1 46 E	1 37	21½
	P. M.			
	1 1	2 34 W	0 21 W	23½
	1 31	2 34	0 50	21½
	2 4	1 15 E	1 10 E	20
	2 30	2 11	3 41	19
	3 0	3 24	4 09	19½
	5 2	0 24	2 01	19½
	6 1	0 24	2 01	16
	6 59	0 56	1 53	13
	9 6	0 26	1 57	9½
	10 1	1 04	2 21	8
	11 2	1 52	2 58	4½
	12 1	0 56	2 06	3
14th	A. M.			
	1 4	1 33	2 32	2½
	2 11	2 11	3 28	2
	3 2	0 48	2 23	4½
	5 05	0 07 W	1 51	10
	6 01	0 31	0 56	14½
	7 5	0 01 E	1 06	20
	9 7	0 05 W	1 25	25
	10 11	0 36	1 13	30½
	11 0	0 54 E	1 36	36
	11 34	0 07	1 11	35
	12 1	1 22	2 08	34
	P. M.			
	1 02	0 53	2 01	28
	2 5	0 19 W	1 32	27½
	2 21	0 34	1 31	35½
	3 08	0 07	1 16	35½
	5 6	0 33 E	0 28	28½
	6 03	0 37	1 41	25½
	7 02	1 06	2 08	22½
	9 41	1 50	3 06	19½
	10 3	1 51	3 19	19½
	10 31	1 51	3 12	18½
	11 1	1 51	3 17	18
	11 31	2 02	3 18	17½
	12 1	2 46	3 32	17
15th	A. M.			
	1 4	1 26	2 42	17
	2 4	0 44	2 34	16½
	3 01	0 40	2 28	16½
	5 9	0 40	2 28	18½

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.1.	Needle No. 2.	Temp.
1825.	A. M.			+
15th	h. m.	° ′	° ′	°
	6 01	0 02 W	2 05 E	19
	7 5	0 11	1 22	22
	9 31	1 37	0 53	27½
	10 01	0 46	1 09	26
	10 29	2 07	0 27	30
	11 1	1 00	0 53	24
	11 29	1 4	0 48	24½
	12 01	0 37 E	1 56	27
	P. M.			
	0 45	2 07		
	1 6	2 37	2 46	31
	1 31	1 07	2 16	29½
	2 01	1 07	2 16	29
	2 31	2 55	2 16	28
	3 01	1 24 W	0 09	30½
	5 02	0 41 E	0 47	28½
	5 59	1 33	1 41	28
	7 3	0 31	1 23	26½
	9 31	0 01	0 47	18½
	10 2	0 09	1 13	18
	10 30	0 16 W	0 02 W	18
	11 4	0 16 E	1 25 E	16½
	11 32	0 16	1 25	16
	12 01	0 16	1 22	15
16th	A. M.			
	1 00	0 45		
	1 15	Zero	1 44	15
	1 31	0 55	1 44	15
	2 03	0 48	1 39	15
	2 31	0 17	1 26	14½
	3 00	0 28	1 26	14
	5 3	0 30	1 10	21½
	6 01	0 33 W	0 36	24
	7 3	1 21	0 04 W	26½
	9 2	1 51	0 28	31½
	10 01	1 51	0 09	31½
	11 3	1 11	0 16 E	36
	11 31	0 39	1 44	36
	12 01	0 36	0 32	35
	P. M.			
	0 40	1 50 E	2 36	36½
	1 0	1 46	2 09	35
	1 20	2 01	1 47	34
	1 52	.....	2 17	30
	2 20	.....	0 34 W	28
	2 40	.....	0 14	27
	3 10	.....	0 08 E	24
	5 5	.....	0 34	23
	6 3	.....	1 47	21
	7 2	.....	1 26	18
	9 3	.....	3 07	15

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.2.	Temp.
1825.	P. M.		+
16th	h. m.	° ′	°
	10 2	3 07 E	14
	11 4	3 07	13
	12 0	3 07	13
17th	A. M.		
	1 00	2 30	13½
	1 30	2 09	14
	2 3	2 09	14
	2 30	1 52	15
	3 5	1 49	16
	5 10	1 53	20
	6 2	1 28	22
	7 2	0 38	27
	9 2	0 10	30
	10 2	1 01	29
	10 33	0 49	26
	11 2	0 56	27
	11 30	1 49	26
	12 3	0 36	24
	P. M.		
	1 4	1 30 W	24
	1 31	1 30	24
	2 0	1 30	24
	2 33	2 14	24
	3 4	3 20	25
	5 2	1 00	25
	5 5	0 05	25
	6 2	0 34	26
	7 2	0 23	24
	9 2	0 18	21
	10 3	0 07 E	19
	11 2	0 20 W	17
	12 3	0 21	17
18th	A. M.		
	1 4	0 21	15
	1 31	0 21	15
	2 0	0 22 E	15
	2 31	0 22	15
	3 4	0 22	17
	4 56	0 42 W	20
	6 0	1 14	29
	7 0	1 11	27
	9 5	0 34	24
	9 32	0 07	24
	10 2	0 29 E	25
	10 32	0 14	24
	11 2	0 18	24
	11 32	0 18	24
	12 0	0 48	24
	P. M.		
	1 2	0 42	23
	1 33	1 07	25

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No 2.	Temp.
1825.	P. M.		+
18th	h. m.	° ′	°
	2 4	1 21 E	27
	2 33	0 28	27
	3 3	2 19	23
	4 58	1 11	26
	6 2	1 08	22
	7 0	1 07	22
	9 36	0 50	21
	10 0	1 23	21
	10 32	0 49	19
	11 11	0 27	18
	11 32	1 51	17
	12 2	1 46	17
19th	A. M.		
	1 4	2 11	16
	2 4	1 36	17
	3 5	1 21	18
	5 2	1 50	21
	6 0	1 50	29
	7 4	0 42	30
	9 30	0 16	30
	10 2	0 40 W	29
	10 30	1 43	29
	11 8	1 20	29
	11 30	0 54	29
	12 01	1 34	29
	P. M.		
	1 10	1 36	24
	1 30	2 12	24
	2 2	2 57	26
	2 32	3 34	25
	3 2	3 34	27
	5 7	0 48 E	25
	6 02	0 48	24
	7 4	0 26	22
	9 30	0 29	16
	10 4	1 18	15
	11 32	1 17	15
	11 5	1 06	15
	11 30	1 06	15
	12 2	0 38	16
20th	A. M.		
	1 10	0 47	15
	1 32	1 11	15
	2 2	0 48	15
	3 0	0 50	15
	5 3	0 24	15
	6 6	0 01	16
	7 3	Zero	27
	9 6	1 20 W	24
	9 28	1 20	24
	10 0	1 20	25

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.2.	Temp.
1825.	A. M.		+
20th	h. m.	° ′	°
	11 2	1 20 W	25
	11 30	2 44	26
	12 0	2 44	28
	P. M.		
	0 46	2 41	30
	1 10	2 48	30
	1 30	3 23	36
	2 0	3 54	32
	2 30	3 48	33
	3 8	3 34	31
	5 5	2 31	23
	6 5	1 15	22
	7 3	1 18	19
	9 6	0 52 E	17
	10 3	0 37 W	16
	11 4	0 37 E	15
	12 0	0 34 W	14
21st	A. M.		
	1 2	0 32	14
	1 30	0 39	14
	3 2	0 40	14
	2 30	0 18	14
	3 4	0 22	14
	5 15	0 23	17
	5 35	0 11 E	17
	6 10	0 29	18
	7 10	0 07	21
	9 3	0 57	32
	10 0	0 46	39
	11 0	1 12 W	28
	11 33	1 31	28
	12 3	1 58	28
	P. M.		
	0 55	1 58	28
	1 28	2 14	29
	2 0	2 14	31
	2 31	2 14	33
	3 0	3 19	35
	5 12	1 14	28
	6 02	1 02	26
	7 02	1 02	24
	9 3	0 42	20
	10 3	0 20	19
	11 3	0 12	18
	11 32	0 03	18
	12 04	0 06 E	17
22d	A. M.		
	1 8	0 06	16
	1 32	0 21	16
	2 0	1 16	16
	2 32	1 21	16

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.2.	Temp.
1825.	A. M.		+
22d	h. m.	° ′	°
	3 6	1 01 E	16
	5 0	1 31	23
	6 0	0 07	22
	7 4	0 08 W	22
	9 33	2 09	24
	10 2	2 59	25
	10 32	3 12	26
	11 0	2 55	26
	11 35	1 27	26
	12 7	0 11	26
	P M		
	1 5	0 23	29
	2 4	0 46 E	27
	3 0	0 22	26
	5 8	1 09 W	24
	6 0	1 11	28
	7 5	0 44	28
	9 32	0 41	22
	10 2	0 41	21
	10 32	0 50	20
	11 12	0 50	19
	11 37	0 42	18
	11 57	1 07	19
23d	A. M.		
	1 2	1 09	18
	2 4	1 14	18
	3 3	1 09	18
	5 10	1 09	20
	6 0	1 24	21
	7 5	1 01	25
	9 30	1 11	25
	10 2	2 00	25
	10 32	1 43	25
	11 6	2 02	26
	11 30	2 18	27
	12 0	2 24	26
	P. M.		
	0 57	3 25	25
	1 35	3 41	24
	2 2	2 42	24
	2 32	2 47	23
	3 7	2 28	23
	5 7	1 18	23
	6 7	1 18	23
	7 5	0 19	21
	9 42	0 20	18
	10 2	0 33	17
	10 30	0 33	16
	11 8	0 07	15
	11 30	0 10	15
	12 0	0 18	14

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.2	m p. ○
1825.	A. M.		+
24th	h. m.	° ′	°
	1 0	0 27 E	12½
	1 32	0 09	11
	2 02	0 46	11
	2 32	0 46	11
	3 08	0 04 W	10
	7 16	1 18	31
	9 7	1 12	34
	9 38	1 42	37
	10 0	1 42	37
	10 30	1 24	38
	11 08	1 09	38
	11 30	1 09	38
	12 0	1 09	30½
	P. M.		
	0 42	1 43	24
	1 08	0 36	21
	1 32	1 10	21
	2 04	1 21	21
	2 32	1 14	21
	3 05	0 38	22
	5 5	0 44	26
	6 5	0 31	35
	7 12	0 50	32
	9 8	0 11	31
	10 5	0 11	20
	11 7	0 15	15
	12 5	2 16 E	14
	A. M.		
25th	0 52	1 42	13
	1 30	2 01	14
	2 2	2 01	15
	2 32	2 20	15
	3 8	2 18	15
	5 2	2 07	19
	6 2	2 28	23
	7 10	0 36	25
	9 01	1 33	32
	10 3	1 40	27
	10 32	0 23 W	27
	11 3	0 31	26
	11 32	Zero	29
	12 2	0 12 E	30
	P. M.		
	1 6	0 12	36
	1 33	0 12	35
	2 2	0 28	41
	2 35	0 04 W	34
	3 6	0 56 E	34
	5 0	1 11	35
	6 2	2 04	41
	7 10	2 26	32

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.2.	Temp.
1825.	A. M.		+
25th	h. m.	° ′	°
	9 3	3 20 E	23
	10 4	2 21	20
	11 4	1 51	19
	12 3	2 02	19
26th	A. M.		
	1 6	2 37	19
	1 30	2 37	19
	2 3	3 16	19
	2 32	3 23	20
	3 8	3 23	21
	4 58	3 03	23
	6 00	3 00	24
	7 6	2 56	25
	9 17	2 46	29
	10 2	1 36	27
	10 32	1 11	27
	11 15	2 53 W	27
	12 2	3 11	27
	P. M.		
	1 0	0 11	31
	2 0	1 26 E	31
	2 40	0 29	33
	4 58	0 41 W	34
	6 0	0 21	27
	7 8	0 28	25½
	9 2	0 07 E	23
	10 0	0 07	22
	10 30	0 11	22
	11 2	0 11	21
	11 32	0 20	21
	12 00	0 20	21
27th	A. M.		
	1 3	0 38	19
	2 3	0 48	19
	3 2	0 36	20
	5 08	0 14 W	20
	6 2	0 14	19
	7 7	0 14	18
28th	A. M.		
	9 7	0 01 E	32
	10 2	0 38	36
	10 30	0 07 W	34
	11 5	0 36 E	36
	11 31	0 08 W	37
	12 4	1 01	39
	P. M.		
	0 42	0 34	37
	1 6	0 24	37
	1 32	0 33	37
	2 00	0 29	38
	2 32	0 09	40

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.2.	Temp.
1825.	A. M.		+
28th	h. m.	° ′	°
	3 04	0 31 W	41
	5 4	1 33 E	35
	6 3	1 35	34
	7 2	1 47	32
	9 7	1 47	37
	10 0	2 39	36
	11 8	2 18	25
	12 0	2 18	25
29th	A. M.		
	1 10	1 47	24
	1 34	1 47	24
	2 3	1 56	24
	2 30	2 16	23
	3 6	1 51	23
	5 0	1 34	22
	6 2	1 43	22
	7 0	1 43	22
	9 4	0 55	23
	10 3	0 55	23
	11 2	1 31	23
	P. M.		
	0 3	0 51	23
	1 0	2 02	26
	1 30	2 02	25
	2 0	2 02	24
	2 30	2 02	24
	3 9	2 02	23
	5 13	2 01	23
	6 17	2 01	23
	7 5	1 15	23
	9 5	1 31	23
	10 3	1 17	23

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.2.	Temp.
1825.	P. M.		+
29th	h. m.	° ′	°
	11 2	1 08 E	23
	12 3	1 30	24
30th	A. M.		
	1 08	1 30	23
	1 33	1 30	23
	2 0	1 03	23
	2 33	1 01	23
	3 07	1 01	23
	5 2	1 26	23
	6 0	1 17	24
	7 4	1 17	25
	9 2	0 31	22
	10 2	0 28	30
	10 32	0 28	33
	11 7	0 50	33
	11 35	0 30	35
	12 0	0 11 W	36
	P. M.		
	1 3	1 24	37
	1 33	2 02	38
	2 03	1 04	37
	3 03	1 04 E	38
	5 2	2 16	37
	6 0	1 37	36
	7 4	1 09	34
	9 0	1 53	31
	10 2	2 09	29
	10 30	2 33	28
	11 8	2 43	27
	11 32	2 39	27
	12 0	2 56	26½

May.	Mean Time of Observation.	Deflections from the line of Zero. Needle No.2.	Temp.
1825.	A. M.		+
31st	h. m.	° ′	°
	1 0	3 02 E	26
	2 3	2 48	26
	2 33	3 11	26
	3 3	3 01	26
	5 31	1 17	28
	6 0	0 42	29
	6 30	2 13	30
	7 5	2 03	32
	9 30	1 36	36
	10 2	1 06	39
	10 30	0 53	39
	11 6	0 01	40
	11 32	0 04	40
	12 0	0 23 W	40
	P. M.		
	0 52	2 08 E	41
	1 32	0 07	40
	2 2	1 24 W	41
	2 30	0 32 E	40
	3 7	0 10 W	37
	5 5	1 16 E	36
	5 58	0 44 W	38
	7 4	1 50 E	35
	9 30	1 44	28
	10 0	1 44	26
	10 30	2 01	24
	11 6	1 56	23
	11 32	1 46	23
	12 0	1 46	23

IV. *Abstract of the daily variation of the magnetic needle No. 2, by Lieut.* FOSTER.

In the following tables are given the times of maximum and minimum diurnal variation, together with the instrumental range and value in arc of such daily change. In an adjoining column are placed indications of the relative position of the moon with respect to the sun; as there seems some reason to think that these bodies have each its influence on the needle: at all events it will be seen, that in every case the daily variation was always greater when the southern declination of the moon was greatest, and commonly a minimum when her declination was increasing to the northward.* The action of the sun, however, was much less equivocal, and its increasing effect on the daily variation was rendered very manifest as he advanced to the northward.

* The following are the means of the maximum ranges of the needle, for every three days nearest to each quadrature, opposition and conjunction.

Months.	1st. Quadrature.	Conjunction.	2d. Quadrature.	Opposition.
	° ′	° ′	° ′	° ′
January	1 25	2 00	1 33	2 6½
February	1 50	1 45	0 57½	0 41
March	2 23	4 15	1 20½	2 53
April	3 20	3 20½	3 5	2 24
May	3 57	4 6	4 2	1 41
Means	2 35	3 5½	2 11	2 9

From these means it appears, that the maximum deviation about the time of conjunction, exceeds those at the quadratures, and opposition, in the ratio of 3 to 2 nearly.

With a view to placing in evidence the proportional part of the annual variation due to each month, the mean of the maximum west and east expressions, has been assumed as the daily zero, or magnetic meridian; but on reference to the column containing it, there appears such irregularities in its directions, as to render any conclusions drawn from it, very unsatisfactory.

January, 1825.

Days.	Times of maximum. Westerly daily variation. A.M.	Westerly daily variation. P.M.	Easterly daily variation. P.M.	Easterly daily variation. A.M. following day	Instrumental range.	Amount of Daily variation.	☉ & ☽	Mean daily zero.	Temperature at Maximum. Westerly daily variation. Inst.	Westerly daily variation. Air.	Easterly daily variation. Inst.	Easterly daily variation. Air.	Aurora.	Prevailing Winds. True Direction.	Prevailing Winds. Velocity.	Prevailing Weather, &c. &c.
	h. m.	h. m.	h. m.	h. m.	° ′	° ′		° ′	°	°	°	°				
1	.....	1 0	12 0	.....	2 41	1 20½	..	41 8½	−16	−26	−26	−26¼	Not vis.	Easterly	Light	Clear and Fine.
2	11 50	.....	.....	7 10	1 46	0 53	..	41 34	24	27	24	29½	——	——	——	Ditto. Ditto.
3	10 0	.....	12 0	.....	1 40	0 50	..	42 13	24	28	33	34	——	——	——	Thin clouds with a haze.
4	10 10	.....	3 0	.....	1 53	0 56½	..	42 3½	25	26	29	33	——	——	——	Hazy.
5	11 10	.....	12 0	.....	5 6	2 33	8	43 1	28½	32½	31	36	——	N. E.	——	A partial haze.
6	9 45	.....	11 5	.....	5 40	2 50	..	42 18	27	29½	29	34	——	Easterly	——	Ditto.
7	9 20	.....	12 0	.....	4 6	2 3	..	41 37	30	36	30	32	——	——	Very light	Fine and clear.
8	.....	.....	.....	.....	.....	.....	..	.....	...	...	...	...	——	——	Fresh	Hazy, with much drift.
9	.....	.....	.....	.....	.....	.....	..	.....	...	...	...	...	——	——	——	Ditto. Ditto.
10	.....	1 0	9 3	.....	2 46	1 23	..	42 15	32	33	33	37	——	——	Light	Clear.
11	12 0	.....	.....	1 7	4 3	2 1½	..	41 11½	33	35	33	38	——	N. E.	——	Ditto.
12	10 10	.....	.....	1 10	1 42	0 51	□	42 10	34½	16	35	38½	Visible	——	——	Ditto.
13	.....	1 0	11 10	.....	2 1	1 0½	..	41 47½	25	18	16	16½	Not vis.	S. E.	——	Small snow.
14	.....	1 20	11 10	.....	2 44	1 22	..	42 23	18½	25	18	20	——	SSE.	Strong	Snow and drift.
15	.....	0 15	.....	2 17	8 26	4 13	..	42 34	25	31	25	27	Visible	East.	Fresh	Fine and clear.
16	.....	0 10	11 10	.....	4 51	2 25½	..	40 46½	28	26½	31	35	——	——	Mod.	A thin haze.
17	8 10	.....	10 15	.....	4 58	2 29	..	41 33	30	24	26½	27	——	——	——	Fine and clear.
18	.....	0 10	6 15	.....	5 52	2 56	..	41 29	22	23	24	22½	——	——	Fresh	Overcast and cloudy.
19	.....	2 10	.....	2 10	3 52	1 56	☌	42 0	18	28	23	23	Not vis.	N. E.	Light	Very hazy.
20	.....	1 55	5 10	.....	2 16	1 8	..	40 20	24	30	28	28	Visible	——	——	Clear and fine.
21	.....	1 40	6 5	.....	2 35	1 17½	..	41 52½	30	27	30	31½	——	Northy	Strong	Very hazy W.
22	.....	0 55	.....	0 5	2 41	1 20½	..	41 3½	29	32	27	29	——	——	Mod.	Cloudy.
23	.....	0 20	8 5	.....	2 32	1 16	..	40 14	25½	34½	32	33½	Not vis.	NNE.	——	Hazy.
24	11 11	.....	.....	1 10	2 7	1 3½	..	41 41½	34	40	34	36	Visible	N. E.	Light	Clear and fine.
25	.....	3 10	10 5	.....	2 25	1 12½	..	40 32½	39	29	40	44	Not vis.	Easterly	——	Fine and clear.
26	10 7	.....	.....	2 5	4 0	2 0	..	40 51	38½	31	29	26½	Visible	——	——	Ditto. ditto.
27	.....	1 10	.....	3 5	3 50	1 55	□	41 35	29	25½	31	33	——	N. W.	Fresh	Hazy, with drift.
28	.....	0 6	6 10	.....	1 28	0 44	..	41 26	29	29	35	27	——	——	——	Ditto. ditto.
29	11 3	.....	2 2	.....	2 10	1 5	..	41 41	28	27	29	28½	——	NNW.	Mod.	Cloudy, with a dense haze.
30	12 0	.....	10 5	.....	3 3	1 31½	..	42 2½	25½	29	30	31	——	Easterly	——	Overcast.
31	8 5	.....	6 10	.....	0 52	0 26	..	41 47	31	32½	35	36	Not vis.	——	Fresh	Thick cloudy weather
Mean	11 46 A.M.		10 50 P.M.		3 14,31	1 37¼	..	41 36	—	—	—	—	—	—	—	—

daily variation of the magnetic needle.

February, 1825.

Days.	Times of maximum. Westerly daily variation. A.M.	Westerly daily variation. P.M.	Easterly daily variation. P.M.	Easterly daily variation. A.M. folg day	Instrumental range.	Amount of Daily variation.	☉ & ☽	Mean daily zero.	Temperature at maximum. Westerly daily variaⁿ. Inst.	Westerly daily variaⁿ. Air.	Easterly daily variaⁿ. Inst.	Easterly daily variaⁿ. Air.	Aurora.	Prevailing Winds. True Direction.	Prevailing Winds. Velocity.	Prevailing Weather, &c. &c.
	h. m.	h. m.	h. m.	h. m.	° ′	° ′		° ′	°	°	°	°				
1	12 0	.....	11 57	.....	1 18	0 39	..	41 41	−32	−33	−35	−36	Not vis.	East	Mod.	Fine and clear.
2	.....	0 3	4 0	.....	1 45	0 52½	..	41 39½	37	40	39½	41½	—	—	—	Ditto. ditto.
3	11 4	.....	3 4	.....	0 35	0 17½	8	41 18½	33	32	26½	26½	—	—	—	Hazy low down.
4	.....	2 0	.....	1 0	1 48	0 54	..	40 48	27	24½	26	26	—	—	—	Ditto. ditto.
5	11 4	.....	2 0	.....	2 29	1 14½	..	41 29½	25	25	25	26	—	NE.	—	Cloudy.
6	.....	0 4	6 0	.....	2 54	1 27	..	40 13	17	16	19	19	Visible.	North	Fresh	Hazy, with drift.
7	.....	2 0	10 0	.....	1 33	0 46½	..	40 47½	22	22½	28	29	Not vis.	East	Light	Fine and clear.
8	7 58	.....	.....	1 57	2 21	1 10½	..	41 20½	30	32	36½	39½	—	Calm	.....	Ditto. ditto.
9	10 58	.....	.....	0 6	1 43	0 51½	..	40 38½	36	39	36½	39½	—	East	Light	Ditto. ditto.
10	6 57	.....	10 58	.....	1 34	0 47	□	40 29	36½	38	32	31½	—	—	—	Not a cloud visible.
11	.....	2 10	.....	1 32	7 46	3 53	..	38 14	31	31½	23	20	Visible.	NW.	—	A few light clouds in zenith.
12	.....	1 25	12 0	.....	5 32	2 46	..	39 46	14	11½	10½	9	—	ESE.	Fresh	Hazy, with drift.
13	.....	2 15	.....	1 3	4 50	2 25	..	40 11	14½	14	24	24	—	—	Light	Very hazy.
14	.....	0 33	10 43	.....	10 0	5 0	..	40 11	25½	21½	31	33	—	NE.	Fresh	Thick and hazy.
15	.....	0 28	.....	1 8	8 50	4 25	..	39 46	27½	30½	31	33	—	North	—	Ditto. ditto.
16	.....	1 58	.....	1 0	3 22	1 41	..	40 46	33½	34	23	29½	—	NNW.	Light	Hazy near the horizon.
17	.....	2 12	.....	1 0	5 32	2 46	..	42 1	18	16½	25	25	Not vis.	North	—	Fine thin clouds.
18	12 0	.....	.....	5 3	1 37	0 48½	♂	41 11½	26½	26	30	32	—	ESE	—	Clear fine W.
19	10 58	.....	.....	2 4	3 50	1 55	..	40 21	27	29	35½	37	Visible.	NE	—	Fine and clear.
20	.....	0 18	10 0	.....	3 22	1 41	..	40 21	31	34½	37	40½	—	—	—	Ditto. ditto.
21	7 0	.....	.....	2 10	3 47	1 53½	..	41 18½	39	42	31½	33	—	North	—	Hazy near the horizon.
22	10 56	.....	.....	1 58	4 21	2 10½	..	40 6½	29	31	29	29	—	Calm	Calm	Fine and clear.
23	10 48	.....	.....	1 8	3 33	1 46½	..	41 6½	25	25	27	27	—	ESE.	Mod.	Hazy.
24	10 4	.....	.....	0 58	0 39	0 19½	..	41 5½	27½	29	29	29	—	East	Fresh	Overcast.
25	10 5	.....	.....	1 6	1 30	0 45	..	40 46	28	31½	27½	27	—	—	Mod.	Fine and clear.
26	.....	1 5	11 0	.....	2 49	1 24½	□	40 51½	16	17	11	8½	Not vis.	—	Strong	Fine, with drift.
27	.....	1 9	9 50	.....	1 28	0 44	..	41 23	11	8½	14	13	—	—	Mod.	Thick and hazy.
28	.....	0 2	.....	2 2	0 39	0 19½	..	41 49½	10	22	24	22½	—	North	Light	Fine and clear.
Mean	11 46	A.M.	11 23	P.M.	3 16	1 38	..	40 48	....	....	....	....	.....	.....	.....	.....

March 1825.

Days.	Times of maximum. Westerly daily variation. A. M.	Westerly daily variation. P. M.	Easterly daily variation. P. M.	Easterly daily variation. A. M. folg day	Instrumental range.	Amount of daily variation.	☉ & ☽	Mean daily zero.	Temperature at maximum. Westerly daily variaⁿ. Inst.	Westerly daily variaⁿ. Air.	Easterly daily variaⁿ. Inst.	Easterly daily variaⁿ. Air.	Aurora.	Prevailing Winds. True Direction.	Prevailing Winds. Velocity.	Prevailing Weather, &c.
	h. m.	h. m.	h. m.	h. m.	° ′	° ′		° ′	°	°	°	°				
1	11 2	.....	4 58	.....	3 53	1 56½	..	41 21½	−27	−33	−33	−38	Not vis.	Variable	Moderate	Hazy with drift.
2	10 5	.....	10 50	.....	2 5	1 2½	..	41 22½	34	45	39	41	——	East	Light	Cloudy.
3	11 22	.....	11 58	.....	4 59	2 29½	..	40 37½	27	26	27	26	——	——	Squally	A. M. fine, P. M. hazy.
4	.....	0 4	9 35	.....	4 0	2 0	..	42 0	22	30	32	34	——	——	Light	Cloudy.
5	10 33	.....	3 2	.....	2 21	1 10½	8	42 30½	26	29	23	30	——	——	——	A. M. hazy, P. M. fine.
6	7 3	.....	10 58	.....	2 53	1 26½	..	41 53½	23	23	36	39	——	Southerly	Strong	Hazy with drift.
7	10 25	.....	.....	2 50	2 24	1 12	..	41 15	29	26	30	31	——	Westerly	Light	A. M. hazy, P. M. clear.
8	11 58	.....	10 40	.....	3 3	1 31½	..	41 53½	25	26	31	32	——	Easterly	——	Cloudy.
9	10 0	.....	3 0	.....	2 15	1 7½	..	41 56½	26	27	24	26	Visible	——	——	Fine and clear.
10	10 7	.....	7 3	.....	2 34	1 17	..	41 13	22	28	30	33	——	——	——	Ditto ditto
11	11 35	.....	11 0	.....	7 19	3 39½	..	42 26½	16	31	33	37	Not vis.	——	——	Ditto ditto
12	11 6	.....	.....	0 3	4 26	2 13	□	42 0	18	31	30	33	Visible	Calm	Calm	Ditto ditto
13	.....	0 23	.....	1 3	6 37	3 18½	..	40 3½	15	32	32	35	Not vis.	——	——	Ditto ditto
14	.....	0 33	.....	5 8	6 40	3 20	..	38 40	14	30	32	33	——	Easterly	Light	Ditto ditto
15	.....	4 30	7 10	.....	2 31	1 15½	..	41 45½	20	24	31	25	——	——	——	Ditto ditto
16	.....	2 8	.....	1 33	3 43	1 51½	..	41 33½	21	25	27	27	——	N. W.	Squally	Hazy with drift.
17	10 3	.....	9 24	.....	2 9	1 4½	..	41 35½	22	24	27	27	——	——	Strong	Ditto ditto
18	.....	0 38	.....	1 5	6 14	3 7	..	42 48	16	20	24	22	——	——	Squally	Ditto ditto
19	.....	1 9	10 18	.....	10 52	5 26	..	40 6	15	21	22	22	——	——	Moderate	Overcast.
20	11 48	.....	.....	4 0	8 22	4 11	☌	40 21	14	20	25	26	——	——	Fresh	Ditto.
21	7 55	.....	.....	1 3	5 48	2 54	..	41 39	20	25	32	35	——	Westerly	——	Ditto.
22	11 46	.....	.....	2 5	3 40	1 50	..	41 30	7	16	30	34	——	Easterly	Light	Fine and clear.
23	.....	1 18	.....	1 32	5 20	2 40	..	40 40	9	26	33	37	——	——	——	Extremely clear.
24	9 28	.....	.....	1 8	3 44	1 52	..	41 17	14	32	34	39	——	Calm	Calm	Ditto.
25	10 4	.....	3 3	.....	3 4	1 32	..	41 58	30	32	13	30	——	Variable	Light	Fine, horizon hazy.
26	10 33	.....	.....	3 4	2 12	1 6	..	41 38	16	24	24	24	——	North	Moderate	Ditto ditto.
27	.....	1 0	.....	1 5	3 58	1 59	..	41 22	6	15	26	25	——	N. E.	——	Hazy.
28	.....	1 12	10 30	.....	1 53	0 56½	□	41 33½	10	18	23	23	——	N. W.	Light	Overcast.
29	10 3	.....	1 28	.....	5 15	2 37½	..	42 45½	5	22	8	19	——	East	——	Cloudy.
30	9 58	.....	.....	1 3	4 43	2 21½	..	41 25½	12	25	31	35	——	——	——	Fine and clear.
31	.....	0 2	.....	3 38	7 24	3 42	..	40 42	12	26	32	36	——	——	——	Ditto ditto.
Mean	11 25 A. M.		10 43 P. M.		4 28.37	2 14¼		41 29½	—	—	—	—	—	—	—	——

daily variation of the magnetic needle.

April 1825.

Days.	Times of maximum. Westerly daily variation. A.M.	Westerly daily variation. P.M.	Easterly daily variation. P.M.	Easterly daily variation. A.M. follg day.	Instrumental range.	Amount of daily variation.	☉ & ☽	Mean daily zero.	Temperature at maximum. Westerly daily variaⁿ. Inst.	Westerly daily variaⁿ. Air.	Easterly daily variaⁿ. Inst.	Easterly daily variaⁿ. Air.	Aurora.	Prevailing Winds. True Direction.	Prevailing Winds. Velocity.	Prevailing Weather, &c.
	h. m.	h. m.	h. m.	h. m.	° ′	° ′		° ′	°	°	°	°				
1	.....	0 58	11 5	.....	8 8	4 4	..	42 11	—10	—25	—31	—35	Not vis.	East	Light	Fine and clear.
2	10 55	.....	.....	1 0	4 1	2 0½	..	41 22½	12	25	28	29	——	——	Fresh	A. M. fine, P. M. hazy.
3	10 0	.....	.....	5 7	4 49	2 24½	8	39 46½	12	23	27	28	——	——	Moderate	Hazy, with small snow.
4	.....	0 3	2 0	.....	5 37	2 48½	..	41 36½	3	19	10	20	——	Calm	——	Fine and clear.
5	9 35	.....	12 0	.....	4 57	2 28½	..	42 36½	2	26	30	35	——	East	Light	Ditto ditto.
6	10 0	.....	3 0	.....	5 19	2 39½	..	41 11	8	26	11	28	——	——	——	Ditto ditto.
7	.....	2 2	.....	1 3	6 33	3 16½	..	41 32½	7	20	28	29	——	——	——	Ditto ditto.
8	.....	1 2	11 12	.....	9 19	4 39½	..	41 24½	10	17	24	25	——	——	Moderate	Ditto ditto.
9	.....	1 2	.....	2 57	11 56	5 58	..	41 38	10	14	17	18	——	——	——	Ditto ditto.
10	.....	.....	.....	.....	.....	.....	..	....	..	....	....	....	....	——	Fresh	Ditto ditto.
11	.....	1 0	.....	0 3	8 6	4 3	□	38 47	+ 1	4	+ 2	+ 2	——	N. N. E.	Strong	Ditto ditto.
12	.....	1 8	.....	6 1	4 19	2 9½	..	40 56½	+13	+15	— 3	— 3	——	——	Squally	Hazy, with drift.
13	.....	1 30	.....	3 7	4 5	2 2½	...	41 5	Zero	3	—14	—16	——	——	Light	Cloudy.
14	.....	0 30	11 0	.....	9 8	4 34	..	40 54	— 4	+ 5	—13	—14	——	Calm	Calm	Hazy.
15	11 0	.....	3 0	.....	2 43	1 21½	..	41 19½	1	8	+ 1	— 6	——	——	——	Ditto.
16	2 0	.....	11 7	.....	6 9	3 4½	..	41 58½	15	+15	— 6	5	——	East	Light	Fine and clear.
17	12 0	.....	.....	0 4	8 35	4 17½	..	43 12½	+24	26	— 8	+ 8	——	——	Moderate	Ditto ditto.
18	6 0	.....	2 32	.....	5 19	2 39½	♂	43 44½	— 3	— 8	+11	2	——	——	Fresh	A. M. fine, P. M. hazy.
19	.....	1 30	.....	2 2	3 43	1 51½	..	43 17½	+ 8	+ 2	Zero	2	——	——	——	Hazy.
20	11 52	.....	9 35	.....	4 27	2 13½	..	43 36½	9	14	+ 5	8	——	——	Light	Ditto.
21	.....	0 6	.....	5 0	5 1	2 30½	..	42 21½	16	17	— 4	1	——	——	Fresh	Cloudy.
22	.....	0 42	3 0	.....	6 8	3 .4	..	41 45	23	19	+25	15	——	North	Moderate	Ditto.
23	.....	2 4	.....	1 5	5 27	2 43½	..	42 31½	9	11	4	7	——	——	——	Hazy, with snow.
24	9 30	.....	.....	3 4	2 38	1 19	..	43 13	5	3	2	1	——	N. W.	Light	Hazy.
25	.....	0 50	.....	1 5	7 23	3 41½	..	44 1½	18	15	½	1	——	——	——	Cloudy.
26	10 4	.....	10 3	.....	4 12	2 6	..	42 0	11	6	— 2	2	——	Variable	——	Ditto.
27	11 2	.....	.....	0 4	4 30	2 15	□	43 58	12	12	Zero	Zero	——	South	——	Hazy, with snow.
28	11 2	.....	11 58	.....	3 45	1 52½	..	43 7½	17	11	— 4	— 4	——	East	——	Ditto.
29	6 3	.....	2 12	.....	4 17	2 8½	..	44 30½	— 1	Zero	+15	+17	——	——	——	A. M. fine, P. M. hazy.
30	.....	1 28	12 0	.....	5 17	2 38½	..	45 6½	+10	+ 2½	— 3	— 5	——	North	——	Cloudy.
Mean	11 13 A.M.		11 13 P.M.		5 45.28	2 52.44		42 13.46	—	—	—	—	—	—	—	—

May 1825.

Days.	Times of maximum. Westerly daily variation. A.M.	Westerly daily variation. P. M.	Easterly daily variation. P. M.	Easterly daily variation. A. M. foll^{g} day.	Instrumental range.	Amount of daily variation.	☉ & ☽	Mean daily zero.	Temperature at maximum. Westerly daily varia^{n}. Inst.	Westerly daily varia^{n}. Air.	Easterly daily varia^{n}. Inst.	Easterly daily varia^{n}. Air.	Aurora.	Prevailing Winds. True Direction.	Prevailing Winds. Velocity.	Prevailing Weather, &c.
	h. m.	h. m.	h. m.	h. m.	° ′	° ′		° ′	°	°	°	°				
1	.....	0 3	10 3	.....	3 50	1 55	..	42 55	+11	+11	+ 2	+ 3	Not vis.	West	Light	Hazy, with small snow.
2	.....	2 4	11 53	.....	2 49	1 24½	8	42 19½	14	9	2	3	—	East	—	Squally.
3	9 33	.....	.....	2 10	3 26	1 43	..	42 48	5	9	1½	3	—	A. M. E. P. M. S.W.	Strong	Much drift.
4	.....	1 10	5 33	.....	10 20	5 10	..	37 50	12	13	18	12	—	———	Fresh	Cloudy, with drift.
5	.....	1 3	.....	0 3	9 56	4 58	..	39 11	25	9	0	1	—	East	Light	Fine and clear.
6	.....	1 2	10 30	.....	11 27	5 43½	..	41 1	21	20	10	10	—	West	—	Hazy.
7	.....	1 29	.....	2 11	10 50	5 25	..	40 10	21	20	12	12	—	East	—	Cloudy.
8	.....	1 28	.....	2 0	9 31	4 45½	..	41 15½	21	21	11	12	—	—	—	Hazy.
9	.....	1 2	.....	2 30	8 46	4 23	..	42 47	27	25	10	14	—	West	Squally.	Hazy, with constant
10	.....	1 2	.....	2 6	5 27	2 43½	□	42 8½	18	11	3	4	—	—	—	Ditto ditto [snow.
11	9 28	.....	.....	0 2	3 59	1 59½	..	43 17½	13	9	3	3	—	—	—	Ditto ditto
12	.....	1 33	....	1 0	6 37	3 18½	..	42 21½	11	15	6	7	—	—	Light	Ditto ditto
13	.....	1 30	2 59	.....	9 58	4 59	..	44 47	21	21	20	21	—	—	—	Ditto ditto
14	6 2	.....	.....	0 2	5 12	2 36	..	45 56	10	9	17	18	—	—	—	Ditto ditto
15	.....	3 2	....	1 15	3 9	1 34½	..	43 21½	28	33	15	14	—	—	—	Ditto ditto
16	.....	2 20	9 3	.....	7 23	3 41½	..	44 1½	28	22	15	16	—	North	Moderate	Ditto ditto
17	.....	3 4	.....	2 0	7 24	3 42	..	38 31½	25	27	15	18	—	N. E.	Fresh	Ditto ditto
18	6 0	.....	3 3	.....	7 6	3 33	☌	42 33	29	27	23	21	—	North	—	Ditto ditto
19	.....	2 32	10 4	.....	9 45	4 52½	..	39 11½	25	22	15	14	—	East	—	Ditto ditto
20	.....	2 0	9 6	.....	9 33	4 46½	..	38 26½	32	31	17	17	—	—	Light	Cloudy.
21	.....	3 0	.....	5 0	9 41	4 50½	..	39 39½	35	29	23	19	—	—	—	Ditto.
22	10 32	.....	2 4	.....	7 57	3 58½	..	39 1½	26	26	27	27	—	—	Fresh	Light clouds.
23	.....	1 35	.....	2 2	8 53	4 26½	..	38 43	24	18	11	10	—	North	—	Small snow.
24	9 38	.....	.....	6 2	8 21	4 10½	..	42 14½	37	19	23	19	—	Calm	Calm	Very fine and clear.
25	11 3	.....	.....	2 33	7 50	3 55	□	44 20	26	25	20	21	—	North	Light	Overcast.
26	.....	0 2	.....	2 3	7 59	3 59½	..	39 4½	27	32	19	21	—	—	Moderate	Cloudy.
27	.....	.....	.....	.....	.....	.....	..	.....	....	....	.....	....	.....	.....	.....	Hazy, with drift.
28	.....	0 4	10 0	.....	7 22	3 41	..	43 6	39	33	36	26	—	West	Fresh	Ditto ditto.
29	.....	0 3	1 0	.....	2 22	1 11	..	44 22	23	27	26	25	—	S. E.	Strong	Cloudy.
30	.....	1 13	.....	2 33	10 26	5 13	..	42 37	38	38	26	27	—	E. S. E.	Moderate	Ditto.
31	.....	2 2	.....	2 34	7 20	3 40	☌	42 20	41	35	28	25	—	—	Calm	Fine.
Mean.	12 25 A.M.		11 19 P.M.		7 29.38	3 44.39	–	40 10.40	—	—	—	—	—	—	—	—

TABLES shewing the Diurnal change in the Intensity of the Magnetic Horizontal Needle at Port Bowen, from February 15th to May 31st, 1825: the time specified in the different Columns being that, during which, the Needle performed 60 Vibrations at every Hour of the above interval.

Days.	A. M. 1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	Noon.	P. M. 1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	Midnight.	Time of Minimum Intensity.	Time of Maximum Intensity.	Daily Change of Intensity.	Temperature of the Atmosphere. In. From.	In. To.	Out. From.	Out. To.	Moon's Age.	Moon's Right Ascension at Noon.	Moon's Declination at Noon.	Remarks.
1825.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	h. m.	h. m.	s.	o	o	o	o	d	o ,	o ,	
Feb. 15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18 05,2	18 01,5	17 51,3	17 51,2	17 50,5	17 46,5	17 52,1	17 56,7	17 53,8	17 43,7	18 00,7	17 41,0	17 46,8	.....	11 24 A.M.	9 57 P.M.	24,2	—23	—29	—31	—33	29	304 33	16 43 S.	
16	17 55,8	.....	18 00,3	18 08,3	18 04,8	18 02,0	18 15,5	18 08,5	18 03,7	17 56,5	17 53,8	17 51,2	17 55,5	17 49,0	17 47,2	17 50,3	17 51,3	17 52,5	17 52,3	17 50,5	17 50,3	17 49,3	17 52,0	17 53,7	6 54	3 02	28,3	22	33	19	37	30	316 22	12 49	
17	17 52,5	17 55,3	18 00,8	17 57,2	17 56,4	17 59,5	17 56,9	17 55,0	17 54,3	17 52,0	17 50,5	18 01,0	17 57,8	17 51,7	17 50,8	17 47,2	17 49,3	17 51,4	17 50,0	.....	.....	17 47,3	17 50,0	17 52,5	12 00	4 01	13,8	17	22	16½	25	1	327 43	8 28	
18	17 55,9	17 57,3	17 56,8	17 58,8	18 04,2	18 04,3	18 02,0	17 59,3	18 00,0	17 52,2	17 49,6	17 49,2	17 50,5	17 52,5	17 54,5	17 55,5	17 54,2	17 50,2	17 53,9	17 54,2	17 53,2	17 56,0	17 54,8	17 54,2	6 9	10 30 A.M.	14,7	21½	24	25	35	2	338 44	3 44	● New moon.
19	18 01,5	18 00,0	18 00,0	18 12,0	18 04,1	17 59,8	18 00,7	18 03,6	18 03,7	17 56,5	18 02,5	17 56,5	17 52,3	17 54,5	17 50,0	17 49,0	17 50,5	17 51,3	17 51,0	17 55,6	17 53,2	17 56,7	17 54,5	17 54,5	4 00	3 58 P.M.	23,0	22	26	28	36¾	3	349 35	0 52 N.	
20	17 55,8	17 57,2	17 58,1	18 00,3	.....	17 59,5	18 00,3	17 59,5	17 58,0	17 56,2	18 07,8	17 58,3	17 53,7	17 50,3	17 50,5	17 57,2	17 54,5	17 53,8	17 54,0	17 54,7	17 57,5	17 55,6	17 57,2	17 59,4	10 53	2 00	17,5	24	30	34	42	4	0 26	5 40	
21	17 54,3	17 54,7	17 57,7	18 00,5	18 09,2	18 03,5	17 59,1	17 57,5	17 58,5	18 04,5	17 51,8	17 50,7	17 49,8	17 50,9	17 54,1	17 50,8	17 50,5	17 43,5	17 48,0	17 50,5	17 50,0	17 54,5	17 57,8	17 58,3	5 08	6 04	25,7	26	28	30	42½	5	11 29	10 10	
22	17 56,5	18 00,0	17 58,3	17 56,4	.....	18 05,5	18 01,0	18 09,0	18 04,5	18 14,8	17 54,9	17 50,3	17 51,5	17 50,0	17 56,0	17 54,0	17 55,9	17 52,2	17 55,2	17 54,7	17 52,7	17 55,7	17 54,0	17 53,2	10 10	2 08	24,8	26	28	29	34	6	22 54	14 19	
23	17 57,2	18 03,6	18 05,2	18 02,6	18 03,4	18 09,5	18 13,7	18 11,1	18 01,5	18 02,3	17 59,3	17 59,6	17 54,5	17 51,3	17 54,0	17 51,4	17 50,1	17 53,7	17 51,8	17 46,3	17 50,7	17 52,2	17 55,0	17 55,3	7 12	7 57	27,4	24	27	25	29	7	34 51	17 56	
24	17 56,5	17 58,0	17 56,3	17 56,2	17 58,5	18 00,6	18 01,5	18 02,7	17 55,8	17 52,8	17 49,4	18 02,4	17 52,3	17 51,5	17 53,3	17 53,0	17 55,2	17 55,2	17 55,4	17 55,2	17 55,6	17 54,1	17 54,9	17 55,2	7 59	11 06 A.M.	13,3	24	26	27	30	8	47 26	20 50	
25	17 55,5	17 55,0	17 55,0	17 55,3	17 58,2	17 57,9	17 59,4	17 58,5	17 59,3	17 58,2	17 59,2	17 58,9	17 55,2	17 49,5	17 53,6	17 53,8	17 52,9	17 54,5	17 55,8	17 56,2	17 54,0	17 54,5	17 54,8	17 54,7	6 57	1 57 P.M.	09,9	24½	27	28	32½	9	60 43	22 49	
26	17 55,0	17 55,8	17 55,4	17 56,0	18 00,2	17 58,1	18 00,5	18 02,2	.....	17 57,3	17 57,0	17 55,5	17 55,7	17 56,5	17 57,6	17 56,5	17 57,4	17 56,8	17 56,6	17 56,9	18 00,0	18 01,5	18 01,3	18 01,5	7 58	1 10 A.M.	07,2	14	25	8	27	10	74 39	23 41	◗ First quarter.
27	18 01,5	18 03,7	18 03,8	18 04,2	18 03,5	18 02,2	18 03,2	18 05,0	18 04,9	18 07,5	18 08,2	18 04,0	18 04,5	18 00,2	18 00,7	18 00,5	17 59,0	18 00,4	18 02,6	18 02,2	18 02,0	18 02,4	18 01,1	18 01,5	11 00	5 10 P.M.	09,2	11	14	9	13½	11	89 05	23 16	
28	18 01,0	18 02,3	18 01,1	18 01,4	18 04,1	18 05,0	18 05,0	18 06,5	18 05,4	18 02,8	18 01,5	18 00,5	17 56,6	17 59,3	17 58,8	17 58,3	17 57,5	17 57,3	17 59,6	17 59,0	17 57,2	17 57,7	17 57,6	17 58,1	7 53	1 00	09,9	13	19	13	31½	12	103 47	21 28	
March 1	17 59,5	18 00,0	17 59,3	18 00,0	18 01,4	18 03,3	18 04,8	18 08,2	18 11,0	18 07,8	18 9,5	17 50,5	17 52,0	17 53,2	17 52,8	17 54,3	17 55,2	17 56,0	17 56,6	17 57,8	17 54,5	17 55,0	17 54,0	17 55,5	9 05	11 59 A.M.	20,5	24	17	45	22	13	118 30	18 18	
2	17 56,3	17 58,0	17 59,1	18 09,3	18 03,0	18 03,0	18 01,8	18 01,0	18 00,5	17 53,2	17 53,6	18 02,2	17 58,8	17 48,5	17 46,5	17 49,0	17 53,6	17 52,8	17 54,4	17 52,7	17 53,5	17 56,2	17 54,2	17 54,0	3 51	3 06 P.M.	22,8	28	24½	47½	39	14	136 38	13 54	
3	17 57,0	17 59,6	18 01,3	18 08,5	17 57,4	17 55,5	17 56,3	17 57,1	18 01,2	18 13,3	18 14,5	17 43,2	17 46,3	17 55,4	17 53,4	17 46,7	17 40,8	17 48,5	17 46,8	17 49,6	17 53,0	17 55,5	17 56,3	17 57,5	11 05	5 12	33,7	29	25	41	25	15	147 22	8 34	
4	17 55,6	17 56,7	17 57,4	17 57,0	17 57,8	18 03,0	18 01,2	18 02,6	18 02,3	17 56,0	17 59,7	17 56,3	17 51,8	17 50,5	17 50,0	17 56,2	17 58,5	17 54,3	17 55,9	17 53,3	17 49,0	17 45,6	17 50,7	17 55,8	6 05	10 4	17,4	26	23	34	27½	16	161 28	2 37	○ 9h 21m.
5	17 57,3	17 58,0	17 59,3	18 07,0	18 00,5	17 59,8	18 05,0	18 01,8	17 55,5	17 51,2	17 52,3	17 48,5	17 53,4	17 57,2	17 54,5	17 53,8	17 58,0	17 55,2	17 54,0	17 55,9	17 52,8	17 53,7	17 54,8	17 55,9	4 10	00 2	18,5	26	23	33	28	17	175 31	3 30 S.	
6	17 57,3	17 56,8	18 06,0	18 09,5	18 04,0	18 09,2	18 02,0	18 03,9	.....	18 01,0	18 01,5	17 49,5	17 50,0	17 54,7	17 54,9	17 54,5	17 52,5	17 51,8	17 52,3	17 52,7	17 56,5	17 56,7	17 54,5	17 56,3	4 06	00 6	20,0	26	22½	39½	22	18	189 37	9 22	
7	17 55,6	17 56,5	17 56,6	18 00,4	17 55,2	17 59,7	17 57,5	17 56,1	17 59,8	17 57,0	17 56,2	17 55,8	17 53,3	17 50,5	17 53,4	17 53,2	17 55,8	17 54,6	17 55,6	17 54,5	17 55,5	17 55,0	17 55,7	17 56,0	3 52	2 7	9,9	27	24	39½	32½	19	203 54	14 33	
8	17 55,2	17 54,5	17 54,8	17 55,0	17 57,6	17 59,5	18 01,0	18 03,8	18 05,7	18 08,1	18 05,5	18 02,3	17 57,2	17 53,3	17 54,3	17 54,0	17 52,0	17 50,0	17 50,2	17 51,4	17 50,5	17 51,2	17 52,7	17 55,0	9 53	5 58	18,1	26	24	32	27	20	218 24	18 45	
9	17 58,5	17 59,5	18 00,0	18 00,2	18 01,6	18 03,8	18 03,0	18 06,5	18 03,8	18 05,7	18 05,2	17 58,7	17 52,5	17 55,4	17 54,2	17 53,7	17 51,0	17 53,1	17 55,7	17 56,2	17 56,3	17 56,8	17 57,0	17 56,2	7 51	5 00	15,5	26	24	31	26	21	233 03	21 42	
10	17 57,1	17 56,6	17 58,8	17 56,1	17 59,0	18 00,7	18 07,2	18 08,2	.....	18 11,5	18 00,2	17 48,5	17 48,7	17 51,0	17 55,8	17 55,2	17 51,8	17 53,7	17 53,7	17 55,1	17 56,5	17 56,2	17 54,8	17 57,0	10 04	0 11	23,0	27	22	35	27½	22	247 40	23 18	
11	17 57,2	17 58,0	17 57,1	17 59,8	17 58,4	17 57,6	17 57,7	17 57,5	18 00,8	18 01,0	18 02,2	18 02,2	17 53,5	17 46,2	17 47,9	17 46,4	17 51,5	17 50,0	17 48,3	17 51,0	17 51,6	17 48,8	17 50,1	17 52,0	11 30	1 52	16,0	27	22	37	28	23	262 00	23 32	☾ Last quarter 2h 26m.
12	17 58,1	17 58,9	17 59,1	17 56,9	18 00,5	17 57,8	17 58,5	18 03,5	18 07,6	17 57,0	18 10,8	18 03,6	17 56,0	17 52,2	17 51,2	17 59,3	17 51,0	17 53,6	17 46,2	17 52,0	17 54,2	17 56,5	17 53,0	17 52,1	11 12	7 3	24,6	27	22	36	28½	24	276 20	22 30	
13	17 56,5	18 00,0	18 04,0	18 04,5	18 04,3	18 03,5	18 03,5	18 06,8	18 04,0	18 02,2	17 50,5	17 56,5	17 53,2	17 52,3	17 57,0	17 59,0	17 59,0	17 56,0	17 55,6	17 53,5	17 54,5	17 55,7	17 57,0	17 57,5	7 57	11 4 A.M.	16,3	26	21	35	26½	25	289 03	20 24	
14	17 58,5	17 58,5	18 01,2	18 03,9	18 00,0	18 04,2	18 02,3	18 07,8	18 19,0	18 10,2	18 09,3	17 59,5	17 53,0	17 48,0	17 52,7	17 54,7	17 52,1	17 54,5	17 53,1	17 55,8	17 58,0	17 53,5	17 56,2	17 56,3	9 18	2 07 P.M.	31,0	27	21	35	27½	26	301 35	17 24	
15	17 56,7	17 57,7	17 59,3	18 03,2	18 00,7	17 58,2	17 55,8	17 59,8	17 58,6	17 57,0	17 57,8	17 59,5	17 57,1	17 55,2	17 52,2	17 50,1	17 45,3	17 47,1	17 50,1	17 50,3	17 53,0	17 55,0	17 56,7	17 56,5	4 01	5 02	17,9	26	20½	33	21	27	313 29	13 42	
16	17 57,5	17 57,7	18 00,3	17 58,0	18 00,2	17 58,0	18 00,2	18 00,6	18 01,5	18 01,5	18 01,8	17 56,6	17 57,0	17 54,2	17 50,7	17 46,6	17 45,3	17 46,9	17 48,8	17 54,5	17 55,7	17 55,8	17 56,7	11 00	6 00	16,5	23½	22	28	21½	28	324 53	9 31	
17	18 01,0	18 00,0	18 00,2	17 59,5	17 59,8	18 01,5	17 57,5	17 59,8	18 06,3	18 04,3	18 06,0	18 07,5	17 58,6	17 56,3	17 52,9	17 51,6	17 53,0	17 50,2	17 49,2	17 50,6	17 53,5	17 54,0	17 56,5	17 58,2	0 06 P.M.	7 12	18,3	24	22	28	22	29	335 56	4 59	
18	17 56,4	17 57,2	17 57,0	17 58,1	17 59,4	17 59,7	17 54,0	17 57,8	.....	18 03,3	18 03,2	17 56,2	18 00,5	17 56,5	17 55,5	17 48,6	17 50,4	17 54,9	17 52,5	17 52,3	17 55,7	17 54,8	17 54,2	17 49,5	17 53,7	10 00 A.M.	3 10	14,7	23½	21	28	19	30	346 48	0 18	
19	17 59,0	18 01,4	18 04,0	18 27,0	18 21,5	18 20,3	18 12,2	18 09,8	17 57,8	17 46,7	17 56,2	18 03,0	17 55,2	17 52,7	17 45,0	17 41,7	17 45,7	17 36,1	17 30,8	17 42,1	17 34,5	17 42,5	17 51,3	17 58,0	4 05	6 56	56,2	23	19½	24	19	1	357 40	4 24 N.	● 4h 23m.
20	.....	.....	.....	.....	18 03,6	17 58,2	18 00,0	17 58,4	17 45,1	17 49,5	17 48,6	17 42,7	17 33,5	17 31,5	17 35,3	17 37,8	17 59,4	18 00,2	17 55,7	17 53,5	17 56,3	17 59,6	17 57,4	17 58,8	5 20	2 00	32,1	21	18	26½	19	2	8 41	8 56	
21	17 59,3	18 01,5	18 11,8	18 20,7	18 07,7	18 20,8	18 23,8	18 02,4	18 38,2	17 51,0	17 52,0	17 56,3	17 49,8	17 56,1	17 58,7	17 57,2	17 52,0	17 46,5	17 53,6	17 57,6	17 55,0	17 55,5	17 56,3	17 55,7	8 59	5 50	51,7	24	19	34	23½	3	20 02	13 10	
22	18 07,0	18 19,8	18 16,4	18 09,3	18 09,6	18 07,6	18 08,0	18 17,7	.....	18 00,0	18 14,0	18 08,7	17 50,5	17 53,0	17 52,8	17 58,0	17 53,2	17 51,7	17 46,5	17 54,0	18 00,2	17 54,8	17 57,0	17 56,3	2 00	7 08	33,3	25	19	36	16	4	31 51	16 54	
23	18 02,2	18 12,0	18 03,6	18 00,0	18 04,5	18 02,0	18 02,2	18 1,5	18 10,8	18 10,5	18 09,7	18 03,0	17 52,8	17 53,9	17 56,5	17 58,4	17 55,6	17 50,5	18 01,8	17 56,7	18 00,2	17 58,5	17 59,0	17 59,0	2 00	6 10	21,5	27	19½	37¾	26	5	44 14	19 57	
24	18 08,0	18 2,5	18 04,1	18 05,8	.....	17 54,7	18 02,0	18 00,2	18 00,7	18 04,9	17 56,0	17 49,1	.....	17 55,7	17 57,0	17 59,5	17 54,7	17 52,2	17 55,0	17 50,5	17 53,2	17 58,9	18 1,4	18 01,1	1 00	Noon.	18,9	30	22	38	28	6	57 13	22 09	
25	18 08,0	17 55,8	17 57,5	17 59,5	17 57,2	17 54,8	17 57,9	17 58,5	17 59,5	18 00,8	17 58,3	17 59,3	17 58,9	17 54,9	17 55,7	17 56,7	17 54,3	17 56,9	17 56,2	17 57,0	17 57,5	17 56,3	17 57,8	17 58,3	1 07	5 00 P.M.	13,7	29	20	39½	30	7	70 45	23 18	
26	17 57,7	17 58,2	17 59,7	17 59,4	18 02,0	18 03,2	18 03,7	18 05,0	.....	18 07,5	17 59,0	17 58,9	17 52,2	17 52,3	17 57,6	17 58,0	17 53,3	17 54,5	17 57,4	17 56,7	17 58,2	17 57,2	17 59,5	17 59,8	10 04	1 07	15,3	26	22	30½	22	8	84 42	23 16	
27	.....	18 01,0	18 03,0	18 04,2	17 58,9	18 00,0	17 59,3	17 57,3	18 05,5	18 04,7	18 04,2	18 03,7	17 57,8	17 53,7	17 55,5	17 56,5	17 57,0	17 57,7	17 57,8	17 58,4	17 55,3	17 56,0	17 58,3	17 59,0	9 04	1 58	11,8	22	17	25½	15	9	98 54	21 57	◗ 3h 10m.
28	18 01,6	18 02,8	18 07,9	18 06,0	18 02,0	17 58,5	18 07,2	17 55,7	18 03,7	18 10,8	18 10,4	18 04,4	18 01,0	18 02,5	17 56,2	.....	17 51,5	17 53,3	17 52,8	17 54,8	17 56,3	17 57,8	17 57,5	17 58,8	10 09	5 01	19,3	24	16	31½	18	10	113 07	19 22	
29	17 59,3	18 00,5	18 02,3	18 03,5	18 03,3	17 57,5	18 04,7	18 08,0	17 57,5	17 51,2	18 14,3	18 18,0	17 46,7	17 48,5	17 48,0	17 56,2	17 53,3	17 55,5	17 53,0	17 59,3	17 58,5	17 59,7	18 01,3	18 02,8	11 57	1 03	31,3	22	18½	28½	19	11	127 14	15 35	
30	18 00,3	18 09,3	18 14,8	18 31,2	18 24,2	18 11,5	18 13,5	18 11,4	.....	18 10,3	17 46,7	17 54,0	18 11,3	17 57,2	17 57,0	17 59,5	17 58,1	17 53,7	17 54,1	17 58,4	17 55,2	17 57,2	17 57,7	17 58,5	3 58	11 01 A.M.	44,5	25	16	32½	21	12	141 11	10 48	
31	18 01,0	18 03,2	18 07,5	18 11,5	18 00,7	18 09,4	18 04,4	17 55,8	18 03,0	18 04,3	18 09,2	18 01,0	17 58,8	17 53,7	17 58,5	17 58,2	17 56,5	17 49,2	17 51,0	17 56,5	17 57,7	17 55,5	17 56,5	18 01,0	4 04	6 00 P.M.	22,3	27	21½	36½	24	13	155 02	5 16	
April 1	18 03,7	18 09,7	18 15,5	18 04,0	18 18,8	18 10,8	18 15,0	18 21,8	18 23,3	18 09,0	17 55,3	17 49,8	17 49,7	17 43,8	17 55,7	17 54,3	17 44,0	17 55,0	17 45,0	17 52,3	17 39,3	17 46,1	17 52,9	17 59,1	9 05	44,0	27½	20½	36	25	14	168 54	1 30 S.	
2	18 05,8	18 04,7	18 04,5	18 08,8	17 57,3	17 53,5	18 13,2	18 17,5	18 00,7	17 57,5	17 56,0	17 53,8	17 46,0	17 47,4	17 53,6	17 56	17 53,5	17 59,8	17 54,7	17 58,3	17 53,7	17 56,5	17 57,0	17 58,0	8 06	1 06	31,5	28½	23	37	23	15	182 56	6 37	○ Full at 18h 23m
3	18 05,1	18 01,2	18 05,2	18 11,3	18 20,2	18 14,3	18 14,5	18 10,3	.....	18 11,0	18 04,2	17 57,5	17 45,7	17 51,2	17 56,4	18 00,5	17 54,3	17 51,9	17 54,3	17 55,1	17 55,5	17 57,3	17 58,7	17 58,6	5 08	1 01	34,5	25	18½	30	18	16	197 17	12 10	
4	17 59,2	18 00,0	17 59,2	18 00,0	17 56,0	18 00,4	18 02,7	18 05,4	18 12,3	18 01,5	18 01,5	18 02,0	17 43,5	17 45,4	17 45,4	17 58,1	18 02,7	18 00,0	17 54,0	17 50,7	17 54,0	17 57,4	18 00,3	9 04	1 02	28,8	24	15	32½	18	17	212 00	16 53	
5	18 02,3	18 02,8	18 03,3	18 07,5	17 58,0	17 59,5	18 06,2	18 01,5	18 01,8	18 00,2	18 06,4	17 47,6	17 51,6	17 56,0	17 55,2	17 57,1	17 55,8	17 55,0	17 50,0	17 49,0	18 02,2	18 02,9	18 00,0	18 01,6	3 58	Noon.	19,9	24	16	35	22½	18	227 01	20 26	
6	18 06,8	18 06,2	18 09,3	17 54,4	18 03,0	18 07,8	18 09,7	18 15,5	18 11,8	18 09,2	18 02,6	18 09,0	17 56,1	17 59,0	18 00,4	18 01,7	18 01,8	17 56,0	17 56,7	17 55,7	18 03,3	18 00,3	18 02,5	7 59	4 00 A.M.	21,1	26½	17	36½	22	19	242 09	22 36	
7	18 01,1	18 04,6	17 58,7	17 58,5	17 56,6	18 00,7	18 06,1	18 01,2	18 05,0	18 06,5	18 07,2	18 08	17 55,2	17 53,5	17 57,0	17 56,0	17 53,0	17 52,8	17 52,6	17 56,6	18 01,8	17 59,7	18 01,5	18 01,5	0 03 P.M.	6 57 P.M.	15,4	26	15½	32	20	20	257 04	23 20	
8	17 59,5	18 09,5	18 05,5	18 05,2	18 01,2	18 09,2	18 12,3	18 03,4	17 58,8	18 22,8	18 06,0	17 51,8	17 56,2	17 50,5	17 44,0	17 53,0	17 43,5	17 37,0	17 41,5	17 34,7	17 44,6	17 45,4	18 00,4	17 58,8	10 00 A.M.	7 55	48,1	24	17½	29½	16	21	271 29	23 12	
9	18 04,0	18 07,3	18 08,2	18 07,5	18 12,0	18 08,0	18 08,2	18 07,5	18 09,7	18 09,2	18 16,1	18 09,7	17 58,5	17 53,9	17 47,8	17 41,4	17 41,5	17 55,0	17 43,0	17 50,2	17 47,2	17 54,4	17 55,4	17 56,5	10 58	3 55	34,7	21	16	25	13	22	285 12	20 51	☾ Last quarter.
10	17 57,5	18 03,8	18 11,0	18 04,4	18 14,5	18 13,3	18 17,7	18 20,2	18 07,2	18 10,0	17 53,5	17 58,5	17 55,6	18 03,5	17 37,9	17 48,2	17 56,8	17 59,2	17 58,7	18 00,5	.....	.....	.....	.....	8 02	3 05	42,3	19	13	18¼	8	23	298 07	18 03	
11	.....	.....	.....	.....	.....	.....	.....	.....	18 25,2	18 27,5	18 24,2	18 12,3	18 09,8	17 59,0	17 53,0	18 05,5	18 05,2	18 05,0	18 06,5	18 03,5	17 58,2	17 58,0	18 03,5	18 05,8	9 57	3 01	34,5	7	+ 1	7	+ 5	24	310 18	14 32	
12	18 19,5	18 10,5	18 16,0	18 18,5	18 16,9	18 15,2	18 17,4	18 20,3	18 16,5	18 19,6	18 12,2	18 12,8	18 10,3	18 08,7	18 08,2	18 06,2	17 59,7	18 01,7	17 56,3	17 58,0	.....	18 07,0	18 06,2	18 11,0	8 00	7 00	24,0	+ 1½	+ 7	+ 4	+ 18	25	321 52	10 28	
13	18 14,0	18 14,5	18 16,7	18 18,5	18 22,8	18 21,5	18 24,8	18 28,5	18 25,8	18 23,1	18 21,2	18 11,8	18 08,4	17 58,6	17 55,6	17 54,0	17 59,5	17 56,5	17 58,5	17 58,3	18 02,5	18 05,6	18 02,5	18 03,3	7 56	3 56	34,5	— 6	+ 1	—14	+ 1½	26	333 00	6 03	
14	18 14,0	18 20,8	18 22,8	18 05,7	18 22,7	18 14,5	18 08,8	18 06,0	18 02,7	18 18,5	17 56,0	18 05,0	17 57,0	18 02,0	17 48,0	17 48,2	17 40,5	17 26,8	17 35,7	17 25,2	17 44,0	17 50,7	18 00,0	18 06,0	2 56	8 00	57,6	— 8	— 3	—15	— 2	27	343 54	1 26	
15	18 07,8	18 11,8	18 11,9	18 10,5	18 00,8	18 00,4	17 55,0	18 02,8	17 59,0	18 04,8	18 00,5	17 42,7	17 47,5	17 47,5	17 52,0	18 01,2	18 11,0	18 08,5	18 08,2	18 07,5	18 00,4	18 08,7	18 08,5	18 10,5	18 09,3	3 03	11 57 A.M.	29,2	—10	— 4½	—15	— 4	28	354 45	3 14 N.	
16	18 12,5	18 06,0	18 12,0	18 13,5	18 07,7	18 39,1	18 30,6	18 31,2	18 52,0	18 25,6	18 16,8	17 57,5	18 10,8	.....	.....	.....	18 24,4	18 19,6	18 19,3	18 17,5	18 20,9	18 33,5	18 37,0	18 36,7	9 08	11 58	54,5	—10	+ 3	—16½	+ 9	29	5 45	7 47	
17	18 40,7	18 43,3	18 44,2	18 54,2	18 27,5	18 37,5	18 39,0	18 44,5	18 49,5	.....	.....	.....	.....	.....	.....	.....	.....	18 53,7	18 29,5	18 29,2	18 32,0	18 23,5	18 20,0	18 18,6	4 05	.....

Abstract of the Results given in the preceding Table of Intensities.

THE following Table is an abstract of the preceding observations on the diurnal change of intensity of the horizontal magnetic needle, at Port Bowen, during the months of February, March, April, and May, in the year 1825.

The second, third, fourth, and fifth columns of this Table, have been formed by dividing the sum of the times of vibration at each hour, for every month, by the number of days, for the mean monthly intensity at each hour; and the last column is formed by dividing the sum of all the times, by the number of days, for a general mean result. In this, however, the observations made in May are not included, in consequence of the re-magnetising of the needle, as stated at the head of the Table of that month's observations.

Monthly and general mean Intensities of the horizontal magnetic Needle for every hour.

Hour.		February.	March.	April.	May.	
		Mean time in performing 60 vib.	Mean time in performing 60 vib.	Mean time in performing 60 vib.	Mean time in performing 60 vib.	General mean independent of May.
	h.	seconds.	seconds.	seconds.	seconds.	seconds.
A. M.	1	1076,8	1079,1	1098,9	916,4	1086,6
	2	1073,5	1083,1	1100,7		1089,4
	3	1075,7	1082,1	1102,7	930,7	1089,1
	4	1080,7	1084,8	1102,7		1091,1
	5	1082,5	1082,8	1101,7	923,2	1090,3
	6	1082,1	1082,4	1105,4		1090,6
	7	1082,8	1082,9	1108,2	922,6	1092,6
	8	1082,9	1083,1	1109,1		1093,4
	9	1080,9	1084,7	1108,1	927,5	1094,2
	10	1079,5	1081,7	1107,1		1091,4
	11	1077,9	1081,9	1101,9	923,6	1089,0
Noon	12	1077,1	1077,4	1093,3		1084,6
P. M.	1	1075,1	1062,6	1092,5	914,4	1081,1
	2	1072,7	1062,6	1106,6		1084,5
	3	1077,9	1076,4	1110,2	905,2	1087,6
	4	1077,4	1073,6	1090,9		1094,9
	5	1073,6	1073,4	1094,0	905,4	1081,7
	6	1073,5	1072,1	1090,7		1086,2
	7	1074,2	1072,0	1089,2	904,4	1079,1
	8	1073,8	1074,0	1088,7		1079,7
	9	1075,1	1074,5	1091,2	906,0	1080,8
	10	1073,8	1074,8	1092,1		1081,3
	11	1075,1	1075,9	1093,3	911,6	1082,3
Midnight	12	1076,3	1077,1	1096,1		1083,9

From the general mean of the above results, it appears, that the maximum intensity of the horizontal needle at Port Bowen, uniformly took place about 7^h P. M.; but the time of minimum intensity is not so well defined, although it seems to happen somewhat later in the morning.

V. *Observations for determining the dip of the magnetic needle.*

Dip of the magnetic needle observed at Woolwich, and at different stations within the Arctic Circle.

In the following Table, is given a general abstract of the dip of the magnetic needle, and of the magnetic intensity, observed at different stations within the Arctic Circle, in the years 1824-25; and of those at Woolwich, both prior, and subsequent to the voyage.

The instruments employed in these observations, were those by Jones, and Dollond, already described in the Appendix to the two preceding voyages of discovery; but on this occasion, other needles were added, the whole being numbered as follows:

No. 1. A rectangular needle, $7\frac{3}{4}$ inches in length, constructed by Jones on Meyer's principle, having a light cylindrical arm at right angles to its axis, for screwing on a small brass sphere.

2. The same needle, with a sphere somewhat larger.

3. The same needle, with a still larger sphere.

4. A plain rectangular needle of the same length as the above.

5. A needle similar to No. 4, but used only for the intensity.

6. A conical needle, by Dollond, $11\frac{1}{2}$ inches in length, having a moveable axis, for shifting into four different positions; used with the instrument of his construction.

7. A plain rectangular needle, of the same length as No. 6, and used in the same instrument; but employed exclusively for the intensity.

It may not be unnecessary to state, that every precaution which suggested itself was taken to insure accuracy, and that the needles were vibrated after each observation, by means of a small piece of magnetised wire, that their axis might not be injured by raising them in the Y's off the agate planes.

Each of the registered observations on the dip, were deduced from five readings of the needle, in each of its different positions.

The observations for intensity, by means of the *time* in which the needles performed one hundred vibrations in the meridian, are deduced from the mean of four hundred vibrations, obtained with the face of the instrument on each side of the vertical, and the needles reversed on their axis, in the two positions.

Date.	Time of Observation.	Latitude North.	Longitude West.	Observer.	Needle.	Temperature. Fah. Air.	Temperature. Fah. Instrt.	Dip of north end of Needle.	Mean Dip.	Intensity. Mean T. in perfors 100 vib.	Intensity. Ratio deduced	Remarks,
1824.	h.					°	°	° ′	° ′			
May 5th	5 A. M.			F.	2	+48,7	+60	70 55,94		sec.		In Mr.C
6	Noon			F.	4	+59	+68	70 6,46	70 9,2 N	364,67	1,00	garden o
7	Noon	Woolwich Common.		F.	5	.....	+57	.....				wich Cor
8	5^h 37^m P. M.			F.	1	+62½	+65	69 25,2				
June 26	10^h A. M. to 4^h P. M.	68 ′ ″ 59 13	53 ′ ″ 12 56	F.	4	+41½	+41½	83 2,6				On Boat
26	6^h to 10^h P. M.	.....	.....	P.	4	+42	+42	82 59,85	82 53,66			one of th
27	8^h P. M. to midnight	.....	.....	F.	1	+44	+45	82 55,9				Fish Isl
28	1^h to 4^h A. M.	.....	.....	F.	2	+44	+44	82 36,3		340,35	1,148	Davis' St
27	2^h P. M.	.....	.....	F.	5	.....	+44	.....	.....			
July 25	Noon	70 56 0	60 52 0	F.	4	+38	+38	84 10,8	84 8,68	.....	.....	On the
25	1^h to 3^h P. M.	.....	.....	P.	4	+42	+42½	84 6,57				Davis' St
Nov. 1	10^h A. M. to 2^h P. M.	73 13 39	88 54 48	F.	4	— 6	— 6	87 42,46				
2	10^h A. M. to 3^h P. M.	.....	.....	F.	2	+3,2	+ 3,2	87 51,7				
3	10^h A. M. to 2^h½ P. M.	.....	.....	F.	1	+ 2	+ 2	87 57,7				
5	10^h A. M. to 6^h P. M.	.....	.....	F.	6	+10	+10	88 16,91				
6	10^h A. M. to 6^h P. M.	.....	.....	F.	6	— 4½	— 4	88 13,75	° ′ 87 55,29	404,94	1,296	
8	10^h 20^m A. M.	.....	.....	F.	7	.....	—13½	.....				
9 & 10	10^h A. M. to 4^h P. M.	.....	.....	P.	6	+ 7	+ 8	87 43,79				
11	9^h A. M. to 2^h P. M.	.....	.....	P.	4	+ 1	+ 8	87 51,62				At Port
12	10^h A. M. till noon.	.....	.....	P.	1	—14	— 8½	87 54,94				on the
12	0^h 30^m to 2^h 30^m P. M.	.....	.....	P.	2	— 9	— 7	87 52,75				side of
1825. 12	3^h to 5^h P. M.	.....	.....	P.	3	—10	— 6	87 47,3				Regent's
Jan. 4	0^h 30^m to 4^h P. M.	.....	.....	P.	4	—27	—25	88 00,17				
5	1^h to 4^h P. M.	.....	.....	P.	4	—36½	—31	87 55,99				The o
6	11^h A. M. to 2^h 30^m P. M.	.....	.....	F.	4	—30	—22	88 10,96	88 5,31			tions in
7	10^h A. M. to 2^h P. M.	.....	.....	F.	1	—35	—33	88 11,2				ber were
7	2^h to 6^h P. M.	.....	.....	F.	2	—36	—25	87 40,05				made by
8	11^h A. M. to 3^h P. M.	.....	.....	F.	6	—33	—29	88 29,49				light; t
10	11^h 45^m A. M.	.....	.....	F.	7	.....	—22	.....	....	404,69	1,298	January
April 26	11^h 30^m A. M. to 3^h P. M.	.....	.....	F.	4	+ 2	— 1	88 16,99				by cand
26	4^h to 7^h 30^m P. M.	.....	.....	F.	2	+ 2	+ 1	88 12,76	88 13,2			and thos
27	6^h 15^m to 8^h 30^m A. M.	.....	.....	F.	1	— 3	Zero	88 9,32				April an
June 2	9^h 20^m to 11^h 30^m A. M.	.....	.....	P.	4	+25	+26	88 6,86				by daylig
2	11^h 40^m A.M. to 1^h 30^m P.M.	.....	.....	P.	1	+26	+28	88 3,07	88 8,12			
2	1^h 50^m to 4^h P. M.	.....	.....	P.	2	+29	+29	88 13,8				
27	9^h 30^m A. M. to 3^h P. M.	.....	.....	F.	6	+47	+48	87 36,77				
28	Noon to 2^h P. M.	....	.....	F.	4	+43	+42	87 34,17	87 44,41			
28	4^h to 6^h P. M.	.....	.....	F.	1	+43	+42	87 52,5				
28	6^h 30^m to 9^h P. M.	.....	.....	F.	2	+40	+41	87 54,2				
27	9^h 30^m A. M.	.....	.....	F.	7	.....	+47	.....	.....	406,50	1,286	
July 27	10^h A. M. to 1^h 30^m P. M.	73 6 17	91 19 52	P.	2	+50	+50	88 2,1	88 2,1	.....	.....	On the
Aug. 13	8^h 45^m A. M. to noon.	72 46 32	91 50 30	F.	4	+42	+47	88 25,44				coast of
13	0^h 20^m to 3^h 30^m P. M.	.....	.....	F.	2	+48	+48	88 12,68	88 19,22	.....	.....	Somerset.
13	6^h 20^m to 7^h 35^m P. M.	.....	.....	F.	1	+42½	+42	88 19,55				
30	8^h to 11^h A. M.	73 9 8	89 1 20	F.	4	+33	+33	88 8,25	88 8,25	.....	.....	..Neill's H
Dec. 3	11^h 30^m A. M.			F.	7	.....	+47½	.....	.....	461,02	1,00	In Mr.Cl
4	11^h 10^m A. M. to 2^h P. M.	Woolwich Common.		F.	4	+47	+47	70 10,1				garden or
4	2^h 50^m to 4^h 37^m P. M.			F.	2	+46	+46	69 54,7	70 00,4	.....	.....	wich Cor
5	1^h 30^m to 4^h 10^m P. M.			F.	1	+45	+45	69 56,5				

Mean dip of the needle at Port Bowen = 88° 1′,23.

VI. *Observations on the diurnal changes in the position of the horizontal needle, under a reduced directive power, at Port Bowen*, 1825. *By Lieutenant* HENRY FOSTER, *R.N. F.R.S. Communicated January* 12, 1826.

THE daily variation of the horizontal needle is a subject which has, for nearly a century, attracted the attention of several accurate observers, whose object was principally limited to determining the hour of the day, when its amount was the greatest, and the times of the needle's successive easterly and westerly motions.

From these observations, however, it could not be ascertained whether the cause of this daily variation proceeded from an actual change in the direction of the magnetic axis of the earth, or whether it arose from some foreign force, acting transversely on the needle, impelling it out of its natural direction. To submit this question to the test of observation, Mr. BARLOW, in 1823, undertook a set of experiments on the daily variation of a horizontal needle nearly neutralized by the application of artificial magnets; under an idea, that if the daily variation proceeded from an actual change in the direction of the earth's magnetism, the needle in this case, as when in its natural state, would merely take up its new direction without any increase of amount; but if it proceeded from a foreign force acting transversely upon it, the needle now having less intensity of direction than when in its natural state, it would yield more easily to this transverse force and give a larger expression, which would

serve to mark with more precision than heretofore, all the circumstances of this daily change. On trial, the amount was found to be very considerably increased; and he, still in pursuit of the same object, now undertook to ascertain the direction which the daily variation impressed upon the needle, when balanced at different azimuths; which was easily done by a slight adjustment of the magnets; and in this way he found that in two positions of the needle, *viz.* when its north end was directed either to N 16° W, or S 16° E, no daily variation, or a very little took place, and that on one side of this line, the needle passed in one direction, and on the other side in an opposite one.

In the memoir which the Author published relative to these experiments, he expresses a wish that some other persons would pursue this enquiry; and as the parts in which we were likely to winter in the recent voyage of discovery under Captain PARRY, seemed highly favourable for the purpose, I determined to avail myself of this circumstance, and to make a regular set of such observations.

With respect to the daily variation, it was soon found, as was expected, that the needle being nearly neutralized by the great amount of dip, no artificial means would be necessary for increasing its amount: all the observations, therefore, on this head, were made with the needles suspended in their natural state, and the following are entirely devoted to the second object, *viz.* of determining the direction which the needle takes in consequence of the daily variation when directed to different points of the compass, and to ascertain the line of no daily variation, or at least that line in which the motion is a minimum.

Mr. CHRISTIE, in pursuing the experiments above referred to, and in those on the effects of temperature on magnets, had made use of an instrument admirably suited to such purpose; and he very obligingly superintended the construction of one somewhat similar for my use; a description and drawing of which he has given in his paper on the effects of temperature on magnets, published in the Phil. Trans. for 1825.

In these experiments, the apparatus was frozen to three firm stone supports, erected in a house built of snow, having the top covered with canvas; the zero on the compass-box was made to coincide with the direction of the needle at 6^h A.M., that being, although somewhat arbitrarily considered (from the mean of the preceding month's observations on the daily variation), the magnetic meridian. The needle used was made of clock spring, very delicate and light, in length 4,5 inches, its greatest breadth at the centre was 0,45 inches, and its extremities terminated in sharp points; the pivot on which it rested was also repolished previous to the commencement of the observations.

Having considerably reduced the directive power of this needle in its natural direction, by the action of two bar magnets, placed in the magnetic meridian, and in the same horizontal plane with it; I began on the 14th of February to register the amount of the daily change at stated intervals throughout the twenty-four hours, the Officers of the ship kindly assisting me, by taking the observations at the times of my attendance to other duties. The states of the two thermometers placed upon the instrument, were also noted at the time of every observation; and to preserve the intensity of the magnets from being affected by any sudden change

of temperature, produced by the approach of the observer, or other causes, they were thickly covered with snow after every adjustment.

During that part of the day when the needles suspended with floss silk indicated westerly variation, the direction of this needle is marked towards the *right hand*, when the *north end passes to the right hand of a person standing outside of the compass-box, and facing the north end of the needle*; and to the *left, when it passes towards the left hand.*

In the following details is given a short description of the adjustment of the magnets to the needle, at the commencement of the observations in each position of its north end; and also the time in which it performed one vibration when under their influence, as well as the ratios in which the directive force was reduced by them; but it must be remembered, that these ratios are mere approximations, since the directive force was always so much diminished, that a sufficient number of vibrations could not be counted, to estimate the duration of one with the required exactness. In the annexed tables every phenomena, such as halos, aurora borealis, winds, state of the weather, and position of the moon, are inserted; together with such remarks, as suggested themselves at the time of observation. There is also inserted in italics in the column of remarks; max. easterly and westerly variation, opposite the hours at which they respectively took place by the suspended needle No. 2, in order to define the time of the day when the motion of this needle was towards the right, or left hand, as above described. And to point out the times of maximum westerly and easterly deflections of this needle, the signs + and — are prefixed to the hours of observation when they respectively happened.

North end of Needle to the North.

The magnets being placed to the north and south of the needle, with their axes coinciding with the magnetic meridian, the north magnet had its north pole, and the south magnet its south pole, directed towards the needle, at the distance of 31,5 inches from the centre of the compass-box. In this position of the magnets, the needle made one vibration in 15 seconds, so that the directive force was reduced in the ratio of 0,14 to 1 nearly.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 14th	0 30	A. M.	N 3 20 E	—19	.....	.....	Calm	Hazy	Aurora faint.
	1 00		4 50	—19	.....	.....	.....	.....	Aurora not vis.
	— 2 00		5 00	—19	.....	.....	.....	.....	*Max. easterly variation.*
	2 25		5 00	—19					
	6 35		5 00	—20	.....	.....	N. Fresh	Ditto	
	6 40		4 30	—20					
	6 45		3 40	—20					
	7 00		1 30	—20	.....	.....	.....	Cloudy to the eastward	
	7 42		North	—20					
	7 52		N 3 00 W	—20					
	10 00		4 30	—20	To the right hand.	.....	N. Light	Clear and fine	
	10 10		5 30	—20					
	11 00		8 00	—20					
	11 17		8 20	—20					
	11 32		8 20	—20					
	11 47		8 40	—20					
	Noon		8 40	—20					
	0 32	P. M.	9 00	—20					
	0 35		10 00	—20	.....	.....	NE Fresh	Squally	*Max. westerly variation.*
	0 37		10 30	—20					
	0 40		10 55	—20					
	+ 0 42		11 00	—20					
	1 5		11 00	—20	.....	.....	NNW	Moderate	
	1 23		11 00	—21					
	2 00		11 00	—21					
	2 20		11 00	—21					
	2 32		10 30	—21					
	2 45		10 00	—21					
	8 10		0 20	—21					
	8 20		N 2 5 E	—21					
	9 33		2 50	—23					
	10 35		8 50	—22½					
	10 37		10 20	—22½					
	10 52		10 40	—23	.....	.....	Ditto	Ditto	*Max. easterly variation.*
	11 2		10 10	—23					
	11 30		10 10	—23					
	11 52		10 00	—23					

North End of Needle to the North.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 15th	0 22	A. M.	N 10 00 E	—24	.....	.....	NNW	Hazy	
	1 00		10 00	—26	.....	.....	Squally		
	1 50		10 00	—26					
	2 00		12 5	—26					
	2 10		13 20	—26					
—	2 16		13 30	—26					
	2 30		13 30	—26					
	6 55		North	—24	.....	.....	NNW	Hazy	
	7 00		N 3 00 W	—24			Fresh		
	7 5		6 00	—24	.....	.....	North		
	7 10		8 20	—24					
	7 12		11 00	—24					
+	7 15		12 00	—24					
	10 7		10 50	—24	To the right hand.				
	10 35		10 30	—24					
	11 00		10 00	—24	.. ..	18 5,2			
	11 10		9 30	—24					
	11 30		9 30	—24					
	11 50		9 30	—24					
	11 55		10 00	—24	.. ..	18 1,5			
	0 10	P. M.	10 00	—23					
	0 30		10 20	—23					
	1 00		10 20	—23	.....	17 51,8	.....	.....	*Max. westerly variation.*
	1 10		10 20	—23					
	1 30		10 30	—23	.....	.....			
	1 57		10 00	—25					
	2 10		9 30	—25					
	2 35		9 00	—26					
	3 00		8 30	—26	.....	17 50,5			
	7 50		4 00	—26					
	8 00		2 30	—25	.....	17 43,7			
	9 00		1 40	—25	.....	18 00,7			
	9 2		N 0 30 E	—25					
	9 37		2 20	—25	.....	.....	Easterly		
	10 17		2 30	—25	.....	17 41	Light		
	11 36		3 10	—25	.....	17 46,8			
	Midnᵗ		3 30	—25					
Feb. 16th	0 45	A. M.	11 00	—25	.....	.....	Ditto	Fine clear	
	0 50		11 40	—25					
	0 57		12 15	—25					
	1 00		13 5	—25	.....	17 55,8			
	1 3		13 30	—25					
	1 7		13 40	—25					
—	1 10		13 50	—25	.....	.....	.....	.....	*Max. easterly variation.*
	1 25		13 00	—25					
	1 30		12 00	—25					

The north end of the needle was now directed to the south; but as observations were afterwards made with the north end of the needle to the north, they are given in this place, to preserve uniformity in the arrangement.

North end of Needle to the North.

At this time the magnets placed north and south of the needle, had their axes inclined to the magnetic meridian at an angle of 22 degrees, and the distance of their nearest ends from the centre of the needle was 32,95 inches. The time in which the needle now performed one vibration, was 10,24 seconds, and the directive force reduced in the ratio of 0,325 to 1.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahren^{t}. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Apr. 15th	1 20	A. M.	N 2 30 E	—10	.....	18 7,8	NE by N	Squally hazy low down	
	1 30		2 40	—10					
	1 50		2 40	—10					
	2 15		2 00	—10	.....	18 11,8			
	3 00		N 0 30 W	—10½	.....	18 11,9			
	4 00		1 20	—11	.....	18 10,5			
	5 10		4 00	—11	.. To the right hand. ..	18 0,8			
	6 00		4 30	—12	.. ..	18 0,4			
	6 50		8 20	—12					
	6 51		8 30	—12	.. ..	17 55			
	8 00		9 30	—11	.. ..	18 2,8			
	9 4		9 30	—11	.. ..	17 59			
	10 5		9 50	— 9	.... ..	18 4,8			
	11 00		10 20	— 7	.... ..	18 0,5	.....	.....	*Max. westerly var.*
	+Noon		10 40	— 7	.. ..	17 42,7	NE mod.	Hazy with drift	This needle was frequently observed to vibrate in very small arcs, as it proceeded to the eastward from its *Max. westerly* position; as well as in its progress again to the westward, from 2^{h} to 6^{h} P. M. It is also worthy of remark that during the same interval, the intensity of the horizontal needle was observed to be very changeable, and the action of the suspended needles very irregular.
	0 30	P. M.	8 00	— 5	.. ..	.....			
	1 00		6 30	— 5	.. ..	17 47,5			
	1 30		6 30	— 5					
	— 2 00		2 10	— 5	.. Oscillatory. ..	17 52			
	2 30		2 10	— 5					
	2 45		5 00	— 5					
	3 00		5 10	— 5	.. ..	18 1,2	*Max. easterly var.*		
	4 30		9 00	— 6	.. ..	18 11	Squally		
	5 5		9 50	— 7	.. ..	18 8,5	with drift		
	+ 5 55		10 20	— 8	.. ..	18 8,2			
	6 55		9 10	— 8					
	6 57		8 40	— 8	.....	18 7,5			
	7 52		8 25	— 9	.....	18 0,4	Lt. breeze		
	9 7		8 00	— 9	.....	18 8,7	from N.		
	10 5		7 20	—10	.....	18 8,5			
	—11 4		6 50	—10	.....	18 10,5	.....	Fine wea.	
	Midn^{t}		6 50	—10	.....	18 9,3	Easterly	Clear and	
Apr. 16th	5 10	A. M.	N 8 50 W	—11	.. To the right hand. ..	18 7,7	light	fine	*Max. westerly var.* happen^{d} at 2^{h} A.M.
	6 00		5 40	—10	.. ..	18 39,1			
	6 20		7 30	— 9½					
	7 00		10 10	— 8½	.. ..	18 30,6			
	8 00		10 40	— 6½	.. ..	18 31,2			
	9 15		10 25	— 2	.. ..	18 52			
	10 10		12 00	— 1	.. ..	18 25,6			
	+10 15		12 5	— 1	.. ..				
	10 30		12 5	— 1					
	11 10		9 30	+ 1	.....	18 16,8			
	11 32		9 20	+ 1					
	0 58	P. M.	7 40	+ 2	.....	17 57,5			
	1 25		7 10	+ 4	.....	18 10,8			
	1 30		6 30	+ 4					
	1 57		6 10	+ 4½					
	3 00		3 20	+ 5					
	4 00		3 30	+ 5					
	5 15		7 10	+ 3½	.....	18 24,4			

North end of Needle to the North.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Apr. 16th	6 00	P. M.	N 7 10W	+ 2½	.....	18 19,6			
	7 00		7 10	Zero	.....	18 19,3			
	8 00		6 50	— 1	.....	18 17,5			
	9 00		5 40	— 3	.....	18 20,9	Calm	Clear and fine	
	9 30		5 30	— 4					
	10 10		5 30	— 4	.....	18 33,5			
	10 30		5 30	— 4½					
	11 10		3 5	— 4½	.....	18 37			
	—11 55		3 00	— 5	.....	18 36,7	.....	.....	*Max. easterly variation.*
Apr. 17th	1 5	A. M.	3 30	— 6	.....	18 40,7			
	2 7		4 10	— 6	.....	18 43,3			
	2 52		4 30	— 7	.....	18 44,2			
	3 10		5 20	— 7					
	4 5		7 30	— 7	.....	18 54,2			
	5 0		8 20	— 7	.....	18 27,5			
	5 30		6 20	— 6					
	6 00		7 30	— 6	.. ..	18 37,5			
	6 30		8 00	— 5	.. ..	.....	Easterly light		
	7 00		8 30	— 5	.. ..	18 39			
	7 30		8 40	— 5	.. ..	18 44,5			
	9 00		8 40	+ 0½	.. ..	18 49,5			
	9 40		11 30	+ 2					
	10 00		12 30	+ 3					
	10 30		13 30	+ 3½					
	11 00		13 30	+ 4					
	11 30		15 20	+ 6					
	+Noon		17 30	+ 6½	.....	.....	.....	.....	*Max. westerly variation.*
	1 5	P. M.	12 50	+ 7					
	1 30		8 00	+ 7					
	2 2		5 00	+ 6					
	9 30		7 00	— 3½	.....	18 32,0			
	10 00		6 10	— 3	.....	18 23,5			
	10 30		6 00	— 4					
	11 00		5 40	— 5	.....	18 20,0			
	11 30		4 30	— 5					
	Midnt		North	— 5	.....	18 46,0	Calm	Clear fine weather.	*Max. easterly variation.*

To the right hand.

North end of Needle to the South.

In this case, the adjustment of the magnets was the same as in the preceding observations on the 14th of February, with this exception, viz. that their ends nearest to the needle were 27 inches from the centre of the compass-box; the needle under these circumstances making 1 vibration in 14 seconds, and the directive force reduced in the ratio of 0,154 to 1.

Date.	Mean Time of Observation.	A. M. or P. M,	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 17th	0 20	A. M.	S 5 20 E	—22	.....	.....	NNW Light	Hazy weather	
	0 45		5 40	—22					
	— 1 00		5 40	—22	.....	17 52,5	.....	.....	*Max. easterly variation.*
	4 40		5 40	—22	.....	17 56,4			
	5 50		5 40	—23½					
	6 15		5 40	—23	.....	17 59,5			
	7 40		5 40	—22	.....	17 55			
	9 00		5 40	—22	.....	17 54,3			
	9 37		5 30	—21½	.....	.....	Calm	Hazy	
	10 7		5 30	—21½	.....	17 52		weather	
	10 30		5 30	—21					
	11 10		5 30	—21					
	11 20		5 20	—21½	.. .. To the left hand.	17 50,5			
	Noon.		3 40	—21½	.. ..	18 1	North		
	0 45	P M.	3 20	—21	.. ..	17 57,8	Light		
	1 20		3 00	—21					
	1 30		2 00	—21					
	1 40		0 50	—21					
	1 45		0 40	—20					
	2 00		0 20	—20	.....	17 51,7	.....	.....	*Max. westerly variation.*
	2 12		South	—20					
	2 30		S 0 20 W	—20					
	2 45		0 40	—20	.. ..	.....	.....	Hazy to	
	+ 3 00		1 00	—20	.....	17 50,8	North Fresh	the eastward	
	3 5		1 00	—20	.....	.....	.....	Clear over	
	3 20		1 00	—20				head and	
	4 12		0 50	—20	.....	17 47,2		to the	
	6 00		0 40	—21	.....	17 51,4		westward	
	7 35		0 40	—21½	.....	17 50			
	8 10		S 1 40 E	—22	.....	.....	.....	.....	Aurora faint to the N. E. by compass. Aurora not visible at 8.30.
	8 30		2 30	—21½	.....	.....	.....	Hazy	
	9 00		2 50	—21½					
	9 30		3 00	—22					
	9 50		4 10	—22					
	10 00		6 00	—22	.....	17 47,3			
	10 10		6 20	—22					
	10 30		6 20	—22					
	11 00		6 20	—22	.....	17 50			
	11 30		6 40	—22					
	Midnt		6 40	—22	.....	17 52,5			

North end of Needle to the South.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 18th	0 15	A. M.	S 6 40 E	—22	.....	.....	NNE Light	Clear	
	0 18		7 10	—22					
	0 30		8 20	—22					
	0 40		8 40	—22					
	0 15		9 20	—22					
	0 55		9 50	—22	.....	.....	NNE	Clear	
	1 00		10 00	—22	.....	17 55,9	Light	.....	*Max. easterly variation.*
	1 5		10 15	—22					
	1 15		10 30	—22					
	1 25		10 50	—22					
	1 35		10 40	—22					
	1 55		10 30	—22	.....	17 57,3			
	2 30		10 30	—22					
	3 00		10 00	—21½	.....	17 56,8			
	3 30		9 40	—22					
	3 56		9 40	—22	.....	17 58,8			
	5 00		9 40	—22	.....	18 4,2			
	6 2		8 40	—22	.....	18 4,3			
	7 12		8 40	—22	.. To the left hand. ..	18 2,0			
	8 8		8 35	—23		17 59,3			
	9 30		7 50	—23		18 00,0	NE Light	Fine and Clear	
	10 00		7 00	—23		17 52,2			
	10 35		6 10	—23					
	11 5		5 30	—23	.. ..	17 49,6			
	11 30		5 20	—23					
	Noon.		5 10	—23	.....	17 49,2			
	+ 0 30	P. M.	5 00	—23	.....	....	.....	.....	*Max. westerly variation.*
	1 00		5 10	—23	.....	17 50,5			
	1 30		5 10	—23					
	2 00		5 10	—23	.....	17 52,5			
	2 30		5 10	—23	.....				
	— 3 00		5 20	—23	.....	17 54,5			
	8 50		5 10	—24½	.....	.....	Calm	Hazy, low to the westᵈ	
	9 30		5 10	—25	.....	17 53,2			
	10 00		5 10	—25	.....	17 56	.....	.....	Needle nearly
	10 30		5 10	—24	.....	.....	Northerly	Clear and	stationary,
	11 00		5 00	—25½	.....	17 54,8	Light	fine	from 0ʰ 30ᵐ
	11 30		5 00	—25					P. M. until
	Midᵗ.		5 00	—25	.....	17 54,2			0ʰ 30ᵐ A. M.
Feb. 19th	0 30	A. M	5 00	—25	.....	18	NNE Lt.	Fine wea.	on the 19th.
	1 00		4 40	—25	.....	18 1,5			
	1 30		4 40	—25					
	1 55		4 40	—25	.....	18 00			
	2 20		4 40	—25					
	3 15		4 40	—25	.....	18 00	Calm	Clear	*Max. easterly variation* took place at 5ʰ 3ᵐ.
	3 55		4 40	—25	.....	18 12			
	6 00		4 40	—25	.....	17 59,8	.....	Hazy	
	7 00		5 00	—25	.....	18 00,7			
	7 25		4 50	—25					

North end of Needle to the South.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 19th	7 40	A. M.	S 4 00 E	—25					
	7 50		3 40	—25	... To the left hand. ...	.....	.....	Overcast	
	8 00		3 40	—25	... ...	18 3,6			
	9 30		3 40	—24	... ...	18 3,7			
	10 00		3 20	—24½	... ...	17 56,5	.....	Snow	
	10 30		3 15	—24½	... ...	18 2,5			
	11 30		3 10	—24½					
	Noon		2 55	—24½	... ...	17 56,5	.....	.....	*Max. westerly variation.*
	0 10	P. M.	2 50	—24½					
	0 20		S 0 30 W	—24½					
	0 30		1 00	—24½					
	0 45		1 10	—24½	.....	.....	.....	Clear	
	1 00		1 10	—24½	.....	18 2,3			
	1 30		1 10	—24½					
	2 00		1 20	—25	.....	17 54,5			
	+ 2 30		1 30	—25					
	2 50		1 30	—25	.....	17 50			
	3 30		1 30	—25					
	4 00		1 20	—26½	.....	17 49			
	5 00		1 20	—26	.....	17 50,5			
	6 5		1 30	—26	.....	17 51,3			
	7 3		1 10	—27	.....	17 51			
	7 45		1 00	—27	.....	17 55,6			
	9 10		1 20	—27	.....	17 53,2			
	9 30		1 00	—27					
	10 00		0 30	—27	.....	17 56,7			
	10 30		South	—27					
	11 00		S 0 30 E	—27	.....	17 54,5			
	11 40		0 40	—27½					
	Midt.		1 00	—27	.....	17 54,5	NE Light		
Feb. 20th	0 35	A. M.	1 20	—27	.....	.....	Calm	Clear and	
	1 00		1 30	—28	.....	17 55,8		fine.	
	1 10		2 00	—28					
	1 30		2 20	—27					
	2 00		2 40	—27	.....	17 57,2			
	2 10		2 50	—26½					
	2 30		3 00	—26½	.....	.....	.....	.....	*Max. easterly variation.*
	2 40		3 00	—26½					
	2 50		3 10	—26½					
	— 3 00		3 30	—26½	.....	17 58,1			
	3 30		3 30	—26½					
	4 00		3 30	—26½	.....	18 00,3			
	6 3		3 20	—28	.. Very little motion to the left hand. ..	17 59,5			
	7 3		3 20	—29	.. ..	18 0,3			
	7 45		3 20	—29	.. ..	17 59,5			
	9 00		3 20	—28	.. ..	17 58			
	9 45		3 10	—28					
	9 55		3 00	—28	.. ..	17 56,2			
	10 20		3 00	—28	.. ..	18 7,8			
	11 36		3 00	—28					

North end of Needle to the South.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 20th	Noon		S 2 50 E	—28	.. To the left hand. ..	17 58,3	Northerly Light	Clear and fine	
	0 7	P.M.	2 00	—28					
	0 30		2 00	—28					
	1 00		1 30	—28	.. ..	17 53,7	.....	.....	*Max. westerly variation.*
	1 22		South	—27					
	2 00		S 0 20W	—28					
	+ 2 5		0 30	—28	.. ..	17 50,3			
	2 10		South	—28					
	2 30		S 0 10W	—28					
	2 55		0 10	—28	.....	17 50,5			
	3 20		0 10	—28					
	3 35		S 3 00 E	—28					
	3 52		3 40	—28	.....	17 57,2			
	5 8		3 50	—28½	.....	17 54,5			
	6 00		3 50	—29	.....	17 53,8			
	7 10		3 40	—29½	....	17 54			
	7 40		3 30	—29½	.....	17 54,7	Ditto	Ditto	
	9 3		3 40	—30	.....	17 57,5			
	9 50		3 40	—29	.....	17 55,6			
	11 00		3 40	—30	.....	17 57,2			
	11 50		3 40	—31	.....	17 59,4	.....	.....	*Max. easterly variation.*
Feb. 21st	0 35	A. M.	3 30	—30					
	1 00		3 40	—30	. Very little motion, and that to the right hand. .	17 54,3	Northerly Light	Clear and fine	
	1 30		3 40	—30					
	2 00		3 40	—30	. .	17 54,7	N. westerly		
	2 30		3 40	—30					
	3 00		3 40	—30	. .	17 57,7			
	3 30		3 49	—30					
	4 00		3 40	—30	. .	18 0,5			
	4 20		3 40	—31	. .	.....	Calm		
	5 5		3 40	—31	.....	18 9,2			
	5 30		3 50	—31					
	6 00		3 50	—31	.....	18 3,5			
	6 28		3 50	—31					
	— 7 00		4 00	—31	.. To the left hand. ..	17 59,1	.....	.....	*Max. Westerly variation.*
	7 35		3 50	—31					
	7 52		3 40	—31	.. ..	17 57,5			
	9 30		3 30	—32	.. ..	17 58,5			
	10 00		3 20	—32	.. ..	18 4,5	Calm	Clear and fine	Observed the needle oscillate in small arcs previous to its becoming stationary from $10^h\ 20^m$ to 1^h P. M.
	+10 20		2 50	—32					
	11 00		2 50	—32	.. ..	17 51,8			
	11 30		2 55	—32					
	Noon		2 50	—32	.....	17 50,7			
	0 30	P. M.	2 50	—32					
	1 00		2 50	—32	.....	17 49,8			
	1 30		3 00	—32	.....	.....	.....	.....	Parhelion on each side of sun. Needle gently oscillating in very small arcs.
	1 40		3 10	—32					
	2 00		3 20	—32	.....	17 50,9			
	2 30		3 30	—32					
	3 6		3 50	—30	.....	17 54,1			

North end of Needle to the South.

Date.	Mean Time of Observation.	A.M. or P.M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′			m. s.			
Feb. 21st	3 10	P.M.	S 4 00 E	—30					
	3 20		4 00	—30					
	3 40		3 50	—30	.....	17 50,8			
	4 55		3 40	—30	.....	17 50,5			
	6 00		3 40	—30	.....	17 43,5			
	7 00		3 40	—32	.....	17 48			
	7 45		7 30	—31	.....	17 50,5			
	— 9 20		7 50	—29	.....	17 50,0	.....	.....	☽ setting to the E N E by compass.
	10 00		7 00	—29	.....	17 54,5			
	10 30		7 00	—29					
	11 00		7 00	—29	.....	17 57,8			
	11 30		6 50	—29	.....	.....	N. westerly, light	Hazy low down	
	Midnᵗ		6 50	—29	.....	17 58,3			*Max. easterly var.*
Feb. 22d	0 30	A.M.	6 50	—29	.....	.....		Clear and fine	At 2ʰ the Aurora suddenly appeared in an arch from north to west by compass, with bright streamers shooting towards the zenith; the needle under the influence of magnets was not affected in any way whatever that I observed after watching it for one-quarter of an hour, when the Aurora became extremely faint.
	1 00		6 50	—29	.....	17 56,5			
	1 30		6 40	—29					
	2 00		6 20	—29	.....	18 00			
	2 15		6 20	—29					
	2 36		6 40	—28½					
	3 00		6 20	—28½	.....	17 58,3			
	3 32		6 20	—28½					
	4 6		6 20	—28½	.. ..	17 56,4			
	5 40		6 10	—28½	.. ..	18 5,5			
	7 00		5 20	—29	.. ..	18 1,1			
	7 50		5 20	—28½	.. ..	18 9,0			
	9 10		5 00	—28½	.. ..	18 4,8			
	9 56		4 50	—28½					
	10 20		4 30	—28½	. ..	18 14,8			
	10 50		3 50	—28½	.....	17 54,9			
	11 20		S 1 00 W	—28½	.....	.....	.. ..	....	*Max. westerly var.*
	+11 50		1 00	—27	.....	17 50,3			
	0 30	P.M.	1 00	—27					
	1 00		0 30	—27	.....	17 51,5			
	1 55		0 30	—27	.....	17 50			
	2 52		0 20	—27	.....	17 54			
	3 52		S 1 00 E	—28	.....	17 56			
	5 00		1 10	—27½	.....	17 55,9	.. ..	.. ..	☽ N. W. by compass.
	5 55		1 10	—28	.....	17 52,2			
	6 24		1 20	—27½					
	7 00		1 30	—28	.....	17 55,2			
	7 35		1 30	—28	.....	17 54,7			
	9 00		2 5	—28	.....	17 52,7			
	9 5		4 40	—28					
	9 12		4 50	—28					
	9 30		4 50	—28					
	10 00		4 50	—28	.....	17 55,7			
	10 30		5 00	—28					
	11 00		5 10	—28	.....	17 54	.....	.....	Aurora faint N. W.
	11 30		5 30	—28					☽ east by compass.
	Midnᵗ		5 30	—28	.....	17 53,2	.....	.....	Aurora from N. to W.

To the left hand.

Calms, succeeded by light airs from the northward.

Hazy near the horizon.

North end of Needle to the East.

The axes of the magnets placed north and south of the needle, were on this occasion inclined to the magnetic meridian at an angle of 22 degrees; the distance of the nearest ends of each, from the centre of the compass-box was 28 inches, and the time of performing one vibration by the needle was 16,4 seconds, so that the directive power now, was to the undiminished force as 0,113 to 1.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb 23rd.	1 00	A. M.	E 1 00 N	—26	.....	17 57,2	Eastward	Clear	
	1 55		E 2 00 S	—27	.....	18 3,6	.....	.....	*Max. easterly var.*
	3 00		10 00	—27	.....	18 5,2	.....	.....	Aurora bright to the north; at 4h brilliant from NW to NE by (compass.)
	4 15		8 00	—27	.....	18 2,6			
	5 30		7 30	—27	.....	18 3,4			
	6 00		7 30	—27	.....	18 9,5			
	6 40		7 30	—27					
	7 00		4 40	—26½					
	7 5		10 00	—26½	.....	18 13,7			
	7 20		19 00	—26					
	7 25		18 30	—26					
	7 30		19 40	—26					
	+ 7 32		20 00	—26					
	7 35		20 10	—26					
	7 40		19 00	—26					
	7 42		18 50	—27	.....	.....	.....	.....	The *max. westerly var.* happened by the suspended needles at 10h 48m nearly. The indications of this needle appear to be rather those of changes of intensity than of direction, since the irregularities (by comparing them with the times of vib. of a hor. needle), were found to follow that law.
	8 8		10 00	—27	.....	18 11,1	Easterly Fresh	Hazy	
	8 12		9 30	—27	.....	.....			
	9 10		4 40	—27	.....	18 1,5			
	9 30		5 00	—27					
	9 40		6 10	—27					
	10 10		6 50	—26½	.....	18 2,3			
	10 30		3 00	—26					
	10 40		4 30	—26					
	11 00		4 00	—26	.....	17 59,3			
	11 30		East						
	11 33		E 1 00 N	—26					
	11 36		0 30	—26					
	11 40		East						
	11 45		E 1 00 S	—25					
	Noon		2 00	—25	.....	17 59,6	East	Hazy	Very cold W.
	0 10	P. M.	1 30	—25	.....	.....	.....	Clear overhead, much drift, weather very cold.	
	0 50		East	—25½	.....	.....	Fresh		
	1 00		E 3 00 N	—25½	.....	17 54,5			
	1 15		4 20	—25½					
	1 25		5 10	—25½					
	1 30		5 10	—25½					
	1 35		5 00	—25½					
	1 45		5 20	—25½					
	2 00		5 30	—25½	.....	17 51,3			
	2 10		5 20	—25½					
	2 30		4 00	—25½					
	3 00		4 00	—25½	.....	17 54			
	3 25		4 00	—25½					
	3 55		4 00	—25½	.....	17 51,4			
	5 30		5 00	—25½	.....	17 50,1			

North end of Needle to the East.

Date.	Mean Time of Observation.	A M. or P. M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 23rd	6 00	P. M.	E 5 00 N	—25½	.....	17 53,7			
	6 40		5 00	—25½	.....	17 51,8			
	7 40		5 00	—26	.....	17 46,3	.....	.....	Aurora faint to the northward.
	— 8 30		6 20	—26					
	8 40		6 00	—26					
	9 00		5 10	—26	.....	17 50,7			
	9 10		4 10	—25					
	9 20		3 30	—25					
	9 30		3 30	—25					
	9 40		3 00	—25					
	9 45		3 20	—25					
	10 00		3 10	—25	.....	17 52,2			
	10 30		3 00	—25					
	10 45		2 30	—25					
	11 00		2 00	—25	.....	17 55			
	11 15		1 40	—25					
	11 30		1 30	—25					
	11 38		1 00	—25	.....	.....	Eastward		
	Midnᵗ		1 00	—25	.....	17 55,3	Fresh	Thick hazy	☽ ESE by comp.
Feb. 24th	0 5	A. M.	0 40	—25	.....	.....		Hazy weather	☽ E bS by comp.
	1 26		East		.....	17 56,5	.....	.....	*Max. easterly var.*
	1 56		E 0 10 S	—25	.....	17 58			
	2 15		0 50	—25					
	2 40		1 00	—25					
	3 10		0 55	—25½	.....	17 56,3			
	5 40		2 30	—26	.....	18 0,6	.....	.....	Aurora faint.
	6 40		5 00	—26					
	+ 7 40		5 30	—27	.....	18 1,5	Squally		
	8 56		5 10	—27	.....	18 2,7			
	9 40		4 45	—27	.....	17 55,8			
	9 55		3 00	—27	.....	17 52,8			
	10 30		2 30	—26½					
	10 50		1 30	—26½	.....	17 49,4			
	11 00		1 00	—26½	.....	.....	.....	.....	*Max. westerly var.*
	11 30		0 40	—26½					Needle proceeding to the northward by gentle vibrations in small arcs.
	Noon		0 50	—26½	.....	18 2,4			
	0 30	P. M	0 30	—26½					
	0 45		0 30	—26					
	1 15		E 0 30 N	—26	.....	17 52,3			
	1 30		1 30	—26					
	— 3 30		2 20	—27	.....	17 51,5			
	4 45		2 00	—26	.....	17 53			
	5 50		2 00	—25	.....	17 55,2			
	6 50		2 00	—25	.....	17 55,4			
	7 15		2 00	—25					
	9 12		1 50	—25	.....	17 55,6	East	Cloudy	
	9 40		1 30	—25½	.....	17 54,1	Fresh		
	10 25		1 30	—26					

North end of Needle to the East.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 24th	10 50	P. M.	E 1 30 N	—26	.....	17 54,9	Mod.		☽ N. by comp.
	11 25		1 30	—26					
	Midnᵗ		1 30	—26	.....	17 55,2			
Feb. 25th	1 00	A. M.	1 40	—26	.....	17 55,5	N. Eastˡʸ	Clear	*Max. easterly*
	3 30		1 40	—26½	.....	.....	moderate		*variation.*
	4 00		1 40	—26½	.....	17 55,3			
	4 20		1 30	—26½					
	5 00		1 20	—26	.....	17 58,2			
	5 30		1 10	—25½					
	5 45		East	—25½	.....				
	5 50		E 3 00 S	—25½					
	6 00		3 00	—25½	.....	17 57,9	.....	.....	Needle gently
	6 3		2 50	—25½	.....	.....	.....	.....	vibrating in
	6 4		3 00	—25½	.....	.....	.....	.....	small arcs.
	+ 6 30		3 10	—25½					
	7 00		3 00	—26	.....	17 59,4			
	7 30		3 10	—26					
	9 45		3 00	—26½	.....	17 58,2	.....	.....	*Max. westerly*
	11 00		3 10	—26	.....	17 59,2	Easterly	Clear and	*var.* took place
	11 46		3 00	—26			light	fine	at 10ʰ A. M.
	0 15	P. M.	3 00	—26	.....	17 58,9			
	1 00		2 30	—26	.....	17 55,2			
	1 20		2 30	—26					
	1 30		2 00	—26					
	2 00		1 30	—26½	.....	17 49,5	Easterly	Ditto	
	2 5		0 20	—26½	.....	.....	moderate		
	2 10		East	—26½					
	2 15		E 1 40 N	—26½					
	3 5		2 00	—26½	.....	17 53,6			
	4 0		2 00	—27	.....	17 53,8			
	— 5 7		2 10	—27	.....	17 52,9			
	6 5		2 00	—27	.....	17 54,5			
	7 0		2 00	—27	.....	17 55,8			
	7 40		2 00	—27	.....	17 56,2			
	9 00		2 00	—27	.....	17 54			
	9 30		2 00	—27					
	10 00		1 50	—27	.....	17 54,5	East	Hazy	
	10 30		1 40	—27			Fresh		
	11 00		1 30	—27	.....	17 54,8			
	Midnᵗ		1 30	—27	.....	17 54,7			

North end of Needle to the West.

What has been said of the adjustment of the magnets at the commencement of the observations at East, obtain here also; except that the axis of each magnet in this instance, was oppositely inclined to the meridian at an angle of 22 degrees, in order to direct the north end of the needle into its present position.

Date.	Mean Time of Observation.	A.M. or P.M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 26th	1 00	A.M.	West	—27	.....	.....	East	Hazy	*Max. easterly var.*
	2 00		W 2 40 N	—27	.....	17 55,8	strong		
	2 35		3 30	—27					
	3 00		3 30	—26	.....	17 55,4			
	3 30		3 30	—26	.....	17 56,0			
	3 55		3 40	—26					
	5 30		4 30	—25	.....	18 00,2			
	— 6 4		4 50	—25	.....	17 58,1			
	7 5		4 40	—25	.....	18 00,5			
	9 30		4 40	—25	.....	18 2,2			
	10 00		4 40	—22	.....	17 57,3			
	11 00		4 30	—21	.....	17 57,0			
	Noon		2 30	—21	.....	17 55,5			
	1 00	P.M.	1 40	—21	.....	17 55,7			
	1 30		1 00	—21	.....	.....	ESE	Strong gales, withdrift.	
	1 45		West	—21					
	1 50		W 1 40 N	—21					
	2 15		1 00	—21	.....	17 56,5	.....	.....	*Max. westerly var.*
	2 20		West	—21					
	2 30		W 0 10 S	—21					
	3 9		West	—19	.....	17 57,6			
	3 50		West	—19	.....	17 56,5			
	+ 5 30		W 0 15 S	—18	.....	17 57,4			
	6 20		W 0 10 N	—17	.....	17 56,8	.....	.....	D WNW by compass.
	6 55		0 10	—17	.....	17 56,6			
	7 40		0 20	—16	.....	17 56,9			
	9 30		0 30	—14½	.....	18 00			
	10 00		0 30	—14½	.....	18 00,5	ESE	Thick &	
	10 30		0 30	—14½	.....	.....	strong	hazy	
	11 00		0 30	—14½	.....	18 1,3	.....	.....	*Max. easterly var.*
	11 30		0 30	—14½					
	Midnᵗ		0 40	—14½	.....	18 1,5			
Feb. 27th	0 15	A.M.	1 00	—14½	.....	.....	Easterly	Thick &	
	1 8		1 20	—14	.....	18 1,5	light	hazy with	
	2 5		1 30	—14	.....	18 3,7		snow	
	3 00		1 40	—14	.....	18 3,8			
	3 50		1 40	—14	.....	18 4,2			
	5 30		1 50	—14	.....	18 3,5			
	6 10		1 50	—14	.....	18 2,2			
	6 30		1 50	—14½					
	7 00		1 50	—14	.....	18 3,2			
	7 55		1 55	—14	.....	18 5,0	Calm	Cloudy	
	9 00		1 55	—14	.....	18 4,9			

North end of Needle to the West.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 27th	9 30	A. M.	W 2 00 N	—14					
	10 00		2 00	—13	.....	18 7,5			
	10 34		3 00	—14					
	11 00		3 40	—12	.....	18 8,2	East	Hazy	
	—11 20		4 00	—13			Light		
	11 46		3 40	—13					
	Noon.		2 30	—13	.....	18 4,0			
	0 20	P. M.	2 20	—12					
	0 30		2 20	—12					
	1 00		2 20	—12	.....	18 4,5			
	2 00		2 00	—12	.....	18 0,2	.....	.....	*Max. westerly var.*
	2 10		1 30	—12	.....	.....	East	Clear	
	2 50		1 00	—12	.....	18 0,7	Moderate		⊙ on north mag. merid.
	4 30		0 50	—12½	.....	18 0,5			
	5 00		0 50	—12½	.....	17 59	Ditto	Cloudy	
	5 34		0 50	—12½					
	6 5		0 50	—13	.....	18 0,4			
	7 10		0 40	—13	.....	18 2,6	Ditto	Very	
	7 55		0 40	—13	.....	18 2,2		Hazy	
	9 30		0 30	—13	.....	18 2			
	+10 5		0 20	—14	.....	18 2,4	.....	.....	*Max. easterly var.*
	10 58		0 20	—14	.....	18 1,1			
	11 30		0 20	—13½					
	Midt.		0 20	—13	.....	18 1,5			
Feb. 28th	0 15	A. M.	0 30	—13½	.....	18 1,0	North	Cloudy	
	1 20		0 40	—13			Moderate		
	1 40		0 40	—13½					
	2 6		0 50	—13½	.....	18 2,3			
	2 30		0 50	—13½					
	3 00		0 50	—13½	.....	18 1,1			
	3 40		0 55	—13½	.....	18 1,4	N. W.	Hazy	
	5 6		1 10	—13	.....	18 4,1	Moderate		
	6 5		1 30	—13	.....	18 5,0			
	7 3		1 40	—13	.....	18 5,0			
	7 50		2 00	—14	.....	18 6,5			
	9 00		3 25	—14	.....	18 5,4			
	9 30		3 30	—14½	.....	.....	North	Clear and	
	— 9 40		3 40	—14			Light	Fine	
	10 15		3 40	—14	.....	18 2,8			
	10 45		3 30	—14					
	11 00		3 00	—14	.....	18 1,5			
	11 25		3 00	—14					
	11 40		2 30	—14					
	Noon		2 30	—14	.....	18 0,5	.....	.....	*Max. westerly var.*
	1 00	P. M.	1 30	—14	.....	17 56,6			
	1 30		West	—14					
	2 00		West	—14	.....	17 59,3			
	2 20		West	—14					
	+ 2 45		W 0 30 S	—15	.....	17 58,8			

North end of Needle to the West.

Date.	Mean Time of Observation.	A. M. or P. M.	Readiug of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Feb. 28th	5 6	P. M.	W 0 20 S	—17	.....	17 57,5	Easterly Light	Clear and Fine	
	6 3		0 5	—18	.....	17 57,3			
	6 55		W 0 20 N	—19	.....	17 59,6			
	7 00		0 30	—19					
	7 55		0 40	—19	.....	17 59,0			
	9 30		0 40	—20	.....	17 57,2			
	10 00		1 00	—20	.....	17 57,7			
	10 30		1 00	—20					
	11 6		1 00	—20	.....	17 57,6	Ditto	Overcast westward	
	11 40		1 00	—20					
	Midt.		1 00	—20	.....	17 58,1			
March 1st	1 00	A. M.	1 00	—19½	.....	17 59,5			
	1 30		1 00	—19					
	2 00		1 10	—18½	.....	18 00	.....	.....	*Max. easterly variation.*
	3 00		2 30	—18½	.....	17 59,3			
	5 10		4 00	—19	.....	18 1,4	S. W.	Hazy	
	6 8		4 30	—19	.....	18 3,3	Moderate	westward	
	7 6		5 00	—20	.....	18 4,8			
	— 7 40		7 50	—20	.....	18 8,2			
	9 00		7 30	—21½	.....	18 11			
	9 30		7 30	—22					
	10 15		7 30	—22	.....	18 7,8	NE by E	Thick	
	10 45		7 30	—23			Fresh	with drift	
	11 15		7 30	—23	.....	18 9,5			
	11 45		5 30	—24	.....	.....	.....	.....	*Max. westerly variation.*
	Noon.		4 00	—24	.....	17 50,5			
	0 8	P. M.	West	—24					
	+ 0 30		W 0 30 S	—24½					
	1 00		0 30	—24½	.....	17 52	NE Fresh	Overcast	
	1 30		West	—24½					
	2 00		West	—24½	.....	17 53,2			
	2 30		West	—24½					
	3 00		W 1 00 N	—25½	.....	17 52,8			
	3 30		1 5	—25½					
	4 4		1 15	—26	.....	17 54,3			
	5 10		1 30	—26	.....	17 55,2	North	Hazy	*Max. easterly variation.*
	6 00		2 00	—26	.....	17 56	Light		
	7 00		2 10	—26	.....	17 56,6			
	7 50		2 10	—26	.....	17 57,8			
	10 30		2 00	—30	.....	17 55,0			
	11 00		2 00	—30	.....	17 54,0	N. Easty	Clear and	D Mag.
	—11 30		2 20	—30	.....	.....	Light	Fine	North.
	Midnt		2 00	—30	.....	17 55,5			

It will be seen, that when the north end of the needle pointed towards the east or west, the direction of its motion during the time of westerly daily variation, is not specified according to the mode described; I have not ventured to do so, in consequence of the many irregularities in its direction, produced by the variations of horizontal intensity, which were always indicated by this needle, and which rendered its direction as to the *right and left hand* during the time of westerly daily variation, very doubtful.

North end of Needle to the S. W.

The distance of the nearest ends of the magnets from the centre of the compass 27 inches; the axis of each magnet was inclined to the magnetic meridian, and the needle under their influence made one vibration in $12\frac{1}{2}$ seconds; so that the directive force now, was to the undiminished force as 0,20 to 1.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahren. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 2d	1 00	A. M.	S 42 00W	—29	.....	17 56,3	Northerly Light	Clear and Fine	
	1 30		41 50	—30					
	2 00		41 30	—29½	.....	17 58			
	2 30		40 50	—30					
	3 20		40 20	—30	.....	17 59,1	Calm		
	4 00		39 50	—30½	.....	18 9,3			
	5 6		40 00	—31	.....	18 3	Easterly Light	Clear and Fine	
	6 8		40 20	—31	.....	18 3			
	7 6		41 20	—31	.....	18 1,8			
	7 54		41 30	—32	.....	18 1			
	9 00		43 20	—32	.....	18 00,5			
	9 30		44 00	—32					
	10 00		45 30	—32	To the left hand.	17 53,2	.....	.....	*Max. westerly variation.*
	10 30		46 10	—31					
	11 00		46 20	—30		17 53,6			
	11 30		45 50	—30					
	0 15	P. M.	45 30	—30		18 2,2			
	0 35		45 30	—30					
	1 00		45 30	—30		17 58,8	.....	.....	At 1h 25′ P.M. the needle commenced moving rapidly to the westward, intensity at that time increasing.
	1 30		49 30	—30					
	+ 1 40		50 15	—30					
	2 00		50 10	—29½	.....	17 48,5			
	2 30		50 00	—29½					
	3 5		48 20	—29	.....	17 46,5			
	3 55		47 40	—29	.....	17 49			
	5 00		44 30	—29½	.....	17 53,6	.....	Very Hazy	
	5 40		44 20	—29½	.....	17 52,8			
	6 15		44 00	—29½	.....	17 54,4			
	7 00		43 55	—30	.....	.....	.....	Clearer	
	7 40		44 00	—30					
	8 00		44 00	—30	.....	17 52,7			
	9 00		44 00	—30½	.....	17 53,5	Easterly Light	Clear and Fine	
	11 00		43 40	—31	.....	17 54,2			
	Midt.		43 00	—31	.....	17 54	.....	.....	*Max. easterly variation.*
Mar. 3d	1 10	A. M.	42 30	—31	.....	17 57,0	Easterly Light	Clear and Fine	
	2 6		40 20	—31	.....	17 59,6			
	3 0		39 50	—31	.....	18 1,3			
	3 50		38 30	—31	.....	18 8,5			
	5 10		40 40	—31	.....	17 57,4	Squally	Hazy	
	5 40		41 20	—31					

North end of Needle to the SW.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			* This sudden change of the needle in an easterly direction is ascribed to a change of horizontal intensity, which is pointed out by the varying intervals in which the needle performed 60 vibrations.
Mar. 3rd	6 15	A. M.	S 41 30W	—31	.....	17 55,5			
	6 50		42 00	—31½					
	7 25		42 50	—31½	.....	17 56,3			
	8 4		42 50	—31½	.....	17 57,1			
	9 50		40 00*	—31					
	9 55		38 30	—29	.....	18 13,3			
	10 20		37 30	—29					
	10 30		37 30	—29					
	—10 55		† 37 00	—29	.....	18 14,5	☽ South magt.		† This change is also considered to be produced by a change of horizontal intensity.
	11 00		38 50	—28½					
	11 20		45 30	—28½					
	11 35		47 10	—28½					
	11 40		47 40	—28					
	11 42		48 00	—28	.....	.....	Easterly	Overcast	*Max. westerly var.* at 11h 22m A.M.
	11 50		49 30	—28			moderate		
	11 55		49 50	—28					
	Noon.		50 00	—28	.. To the left hand. ..	17 43,2			
	0 15	P. M.	50 00	—28	.. ..	.....	ESE	Hazy	
	1 10		49 40	—28	.. ..	17 46,3	Fresh	with drift	
	1 40		49 30	—28					
	2 20		49 00	—28	.. ..	17 55,4			
	2 50		48 40	—28					
	3 10		48 40	—28	.....	17 52,4			
	3 45		48 40	—28	.....	17 46,7			
	+ 5 6		53 20	—27	.....	17 40,8			
	6 5		51 10	—27	.....	17 48,5	East, strong; thick near the horizon, clear over head.		
	7 4		51 00	—27	.....	17 46,8			
	7 50		45 30	—27	.....	17 49,6			
	9 30		45 30	—27	.....	17 53			
	10 15		45 25	—26½	.....	17 55,5			
	11 10		44 20	—26	.....	17 56,3			
	11 12		43 50	—26	.....	.....	.....	.....	*Max. easterly var.*
	11 45		42 30	—26½	.....	.....	ESE	.....	11h 30m ☽ true South
	Midnt		42 30	—26½	.....	17 57,5	moderate	Hazy	
Mar. 4th	0 10	A. M.	42 30	—26½	.....	.....	ESE	Overcast	
	0 35		42 30	—26½			Squally	with drift	
	1 20		42 30	—26½	.....	17 55,6			
	1 55		42 30	—26	.....	17 56,7			
	2 20		42 30	—26					
	2 50		42 40	—26	.....	17 57,4			
	3 10		42 40	—26½					
	3 55		43 00	—26½	.....	17 57			
	5 12		43 40	—27	.....	17 57,8			
	— 6 6		40 30	—27	.....	18 3,0	Easterly	Clear and	
	7 8		41 40	—27	.....	18 1,2	Light	Fine	
	7 50		42 50	—27	.....	18 2,6			
	9 00		40 30	—27	.....	18 2,3			
	9 40		41 40	—26½	.....	17 56			
	10 10		44 00	—26½	.....	.....	Calm	Clear and	
	10 25		45 00	—26				Fine	

North end of Needle to the S. W.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m,		o ′	o		m. s.			
Mar. 4th	10 40	A. M.	S 45 00W	—26					
	11 5		45 20	—26	.. To the left hand. ..	17 59,7			
	11 10		46 20	—26					
	11 50		46 20	—26					
	0 30	P. M.	47 10	—26	.. ..	17 56,3			
	1 00		47 20	—25	.. ..	17 51,8			
	2 00		47 40	—25	.. ..	17 50,5	Calm	Ditto	*Max. westerly variation.*
	2 5		50 00	—25					
+	2 10		50 25	—25					
	2 35		50 25	—25					
	2 38		49 30	—25					
	3 00		49 5	—25	.....	17 50			
	3 32		47 40	—25					
	4 00		47 00	—25	.....	17 56,2			
	4 5		46 30	—25	.....	.....	Easterly Light	Fine clear weather	
	4 7		46 00	—25					
	5 10		45 10	—25	.....	17 58,5			
	6 3		45 5	—26	.....	17 54,3			
	7 6		45 0	—26	.....	17 55,9			
	7 50		45 0	—27	.....	17 53,3			
	9 00		44 50	—26½	.....	17 49			
—	9 30		44 40	—27					
	10 10		44 50	—27	.....	17 45,6	Easterly Light	Veryclear and fine	*Max. easterly variation.*
	10 50		44 50	—27½	.....	17 50,7			
	11 30		44 50	—27½					
	11 56		44 50	—27½	.....	17 55,8			

North end of Needle to the N. W.

In this case, the ends of the magnets nearest the needle were 29,4 inches from the centre of the compass-box, and the time of performing one vibration by the needle thus circumstanced was 14,4 seconds, so that the directive force now, was to the undiminished force as 0,15 to 1.

Mar. 5th	2 10	A. M.	N 48 00W	—26	.. To the right hand. ..	17 58	Easterly Light	Hazy	
	2 30		48 00	—26					
	3 00		48 10	—26	.. ..	17 59,3			
	3 10		49 10	—26					
	3 15		50 00	—26					
	3 20		50 30	—26					
	4 00		51 30	—26	.. ..	18 7			
	5 10		52 00	—26	.. ..	18 0,5	Westerly moderate	Thick & Hazy	
	6 6		51 30	—26	.. ..	17 59,8			
	7 6		51 30	—26	.....	18 5,0			
+	7 50		52 00	—26	.....	18 1,8			
	9 30		50 10	—25½	.....	17 55,5			
	10 30		49 00	—26	.....	17 51,2	Calm	Clear and fine	*Max. westerly variation.*
	11 00		48 40	—26	.....	17 52,3			
	11 30		49 00	—26					
	11 35		48 30	—26					
	Noon		47 00	—25½	.....	17 48,5			

North end of Needle to the N. W.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 5th	1 00	P. M.	N 46 00W	−25½	.....	17 53,4			
	1 30		45 40	−24½					
	2 00		45 40	−24½	.....	17 57,2			
	2 30		46 10	−24½	.....	.....	Westerly	Clear and	*Max. easterly variation.*
	3 00		46 10	−25	.....	17 54,5	Light	Fine	
	3 20		44 00	−25					
	— 3 50		43 50	−25	.....	17 53,8	.....	.....	
	4 55		44 00	−26	.....	17 58			
	6 5		44 00	−27	.....	17 55,2	Calm	Fine and Clear	
	6 45		44 00	−27	.....	17 54			
	7 40		44 20	−27	.....	17 55,9	Easterly	Cloudy	
	9 10		45 20	−26½	.....	17 52,8	Light		
	9 32		45 20	−27					☽ rising S.W. by W. by compass.
	9 58		45 30	−27	.....	17 53,7			
	10 30		45 45	−27					
	11 4		45 35	−27	.....	17 54,8	.....	.....	
	11 27		45 30	−27	.....	.....	South	Hazy	☽ W ½ N. (compass).
	Midnᵗ		45 30	−27	.....	17 55,9	moderate	.....	
Mar. 6th	1 10	A. M.	46 00	−27	.....	17 57,3	Ditto	Hazy	☽ W N W (compass).
	1 50		46 10	−27	.....	17 56,8			
	2 30		46 30	−27					
	3 00		48 50	−27	.....	18 6			* Needle was observed to oscillate quickly in small arcs, and about this time also, rapid changes in the intervals of the times of vibrations of the horizontal needle took place.
	3 25		49 30	−26½	To the right hand.				
	3 40		51 00	−26½					
	3 50		52 30	−26½					
	3 55		53 20	−26½	.. ..	18 9,5			
	5 5		54 00*	−25	.. ..	18 4	South		
	+ 6 10		60 00	−24	.. ..	18 9,2	Squally	Hazy	*Max. westerly variation.*
	7 5		52 30	−23	.. ..	18 2			
	7 53		54 00	−23	.. ..	18 3			
	9 00		57 20	−23					
	9 5		57 00	−23					
	9 40		58 10+	−23					
	9 45		57 30	−23					
	10 00		50 00	−23	.....	18 1			
	10 30		49 10	−23	.....	.....	South	Overcast	
	10 50		51 30	−23			Fresh.		
	11 00		53 20	−23	.....	18 1,5			
	11 5		54 30	−23					
	11 10		55 30	−23					
	11 15		55 40	−23					
	11 29		54 30	−23	.....	.....	S Westˡʸ	Thick	Immediately after 11ʰ 29ᵐ A. M. the needle went rapidly towards the north, at which time, also, it was observed that a considerable increase in the horizontal intensity took place.
	11 31		50 30	−23			Fresh	with drift	
	Noon.		49 10	−23	.....	17 49,5			
	0 5	P. M.	47 00	−23					
	0 30		46 55	−23					
	1 2		46 45	−23	.....	17 50	Ditto	Clear	
	1 27		46 00	−23					
	1 55		45 55	−23	.....	17 54,7			
	— 2 53		45 00	−24	.....	17 54,9			

North end of Needle to the N. W.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daliy variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 6th	3 20	P. M.	N 45 00W	—24	.....	.....	.....	.....	
	3 45		45 00	—25	.....	17 54,5	S W mod.	Hazy	
	5 15		45 40	—27	.....	17 52,5			
	5 50		45 50	—27					
	6 15		46 00	—27	.....	17 51,8	West		
	6 50		46 00	—27	.....	.....	Mod.	Hazy	
	7 15		46 10	—28	.....	17 52,3			
	7 50		46 10	—29	.....	17 52,7			
	8 54		46 00	—29	.....	17 56,5			
	9 15		45 50	—29½					
	9 45		46 00	—30					
	10 5		46 00	—30	.....	17 56,7	Ditto	Ditto	*Max. easterly variation.*
	10 58		46 10	—30½	.....	17 54.5	Stars scarcely visible		
	11 50		46 10	—31½	.....	17 56,3	through the haze.		
Mar. 7th	1 10	A. M.	46 30	—31	.....	17 55,6	Westerly	Very hazy	
	2 3		47 30	—31	.....	17 56,5	Mod.		
	3 0		48 00	—31	.. ..	17 56,6			
	3 53		48 30	—31	.. ..	18 0,4			
	5 10		49 10	—31	.. ..	17 55,2			
	5 40		50 20	—31					
	6 10		50 30	—31½	.. ..	17 59,7			
	6 50		50 50	—31½	.. ..	17 57,5			
	7 15		50 50	—31½	.. ..	.....	North	Hazy	
	7 50		51 00	—31½	.. ..	17 56,1	Light		
	9 5		50 40	—31½	.....	17 59,8			
	+ 10 0		51 10	—30½	.....	17 57	.....	.....	*Max. westerly variation.*
	10 35		51 10	—30½					
	10 40		51 00	—30	.....	.....	Calm	Clear and fine weather, a few thin clouds near the horiz.	
	11 10		51 00	—30	.....	17 56,2			
	11 30		50 55	—30					
	0 5	P. M.	50 50	—30	.....	17 55,8	N W light		
	0 7		50 00	—30					
	0 9		49 40	—30					
	0 20		49 30	—30					
	1 10		49 20	—29½	.....	17 53,3			
	1 40		48 30	—29					
	1 55		47 50	—28½	.....	17 50,5			
	2 20		47 40	—28½					
	2 50		47 40	—28½					
	3 10		47 40	—28½	.....	17 53,4			
	3 58		47 30	—28½	.....	17 53,2			
	5 5		47 40	—29	.....	17 55,8	Easterly	Very fine	
	6 5		47 50	—29	.....	17 54,6	Light	and clear	
	7 3		48 00	—30	.....	17 55,6			
	— 7 52		47 20	—30	.....	17 54,5	.....	.....	*Max. easterly var.* happnd at 2ʰ 50ᵐ A. M. on the 8th.
	9 5		47 20	—30	.....	17 55,5			
	9 42		47 40	—30					
	10 00		48 00	—30	.....	17 55	Easterly	Hazy	
	11 00		48 30	—30	.....	17 55,7	Mod.		
	11 30		48 30	—30					
	Midnᵗ		48 20	—30	.....	17 56	.....	Very thick weather	

To the right hand.

North end of Needle to the W. S. W.

In this position, both magnets were placed to the south of the compass; the north pole of one magnet, and the south pole of the other, were directed towards the needle, so as to attract each extremity; the distance from the centre of the box, to the end of the magnet attracting the north end of the needle, was 18,65 inches, and to that attracting the south end of the needle, 28,4 inches; the needle then made 1 vibration in 8,6 seconds, so that, the directive force was reduced in the ratio of 0,42 to 1.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrent. / Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 14th	1 5	A. M.	S 68 30W	—26	.....	17 58,5	Calm	Fine and clear, star light	*Max. easterly variation.*
	2 0		68 30	—27	.....	17 58,5			
	2 20		68 30	—27					
	2 50		68 30	—27					
	3 10		68 30	—27	.....	18 1,2			
	3 55		68 30	—27	.....	18 3,9			
	5 10		70 50	—27	.....	18 00			
	5 50		70 10	—27					
	6 5		69 20	—27	.. To the left hand. ..	18 4,2			
	7 00		69 35	—27½	.. ..	18 2,3			
	7 30		69 20	—27½					
—	8 00		68 20	—27½	.. ..	18 7,8			
	9 00		68 20	—27½	.. ..	18 19			
	9 40		68 40	—27½					
	10 30		69 00	—27½	.. ..	18 10,2			
	10 45		68 20	—25					
	11 00		68 30	—25	.....	18 9,3			
	11 40		69 00	—25	.....	.....	Easterly	Clear and	
	Noon		71 15	—25	.....	17 59,5	Light	fine	
	0 30	P. M.	71 50	—23	.....	.....	Easterly	Clear and	*Max. westerly variation.*
	0 35		72 00	—23			Light	fine	
	0 40		71 55	—23					
	0 45		72 00	—23					
	0 50		72 30	—23					
	1 00		72 30	—23	... .	17 53,0			
	1 10		73 00	—23					
	1 20		73 30	—23					
	1 30		74 30	—22½					
	1 35		75 00	—22½					
	1 45		75 30	—22½					
	2 00		75 30	—22	.. To the left hand. ..	.....	Calm	Clear and	
	2 5		75 40	—22		17 48		fine	
	2 7		76 00	—22					
	2 15		76 15	—22					
	2 20		76 30	—22					
	2 30		76 50	—22½					
+	2 40		77 00	—22½	.....	.....	.....	.....	
	3 5		77 00	—22½	.....	17 52,7			
	3 27		76 55	—22½					

North end of Needle to the W. S. W.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 14th	4 26	P. M.	S 76 20W	−22½	.....	17 54,7			
	4 30		76 15	−22½					
	5 00		75 00	−23	.....	17 52,1			
	5 30		74 10	−23					
	5 45		74 00	−23½					
	6 00		73 30	−23½	.....	17 54,5			
	6 10		73 00	−23½					
	6 30		72 50	−24½					
	7 12		72 40	−25½	.....	17 53,1	Calm	Clear and fine	
	7 50		72 40	−25	.....	17 55,8			
	9 25		72 50	−27	.....	17 58			
	10 20		72 50	−27	.....	17 53,5			
	11 50		72 50	−27	.....	17 56,3			
Mar. 15th	1 00	A. M.	72 40	−27	.....	17 56,7	Calm	Clear and fine	
	1 32		72 30	−27					
	1 56		72 15	−27	.....	17 57,7			
	2 50		72 00	−27	.....	17 59,3			
	3 30		71 40	−27					
	3 55		71 30	−27	.....	18 3,2			
	4 25		71 30	−27					
	— 5 6		70 50	−28	.....	18 0,7	.....	.....	*Max. easterly var.*
	5 30		70 50	−28					
	6 00		70 50	−27½	.....	17 58,2			
	6 50		70 50	−27½					
	7 15		70 50	−27½	.....	17 55,8			
	7 30		71 00	−27½	.....	17 59,8			
	9 10		71 00	−27	.....	17 58,6	N.wester Light	Hazy	
	9 42		71 00	−26					
	10 15		71 35	−25	.. To the left hand. ..	17 57			
	10 40		71 50	−24½					
	11 14		72 20	−24	.. ..	17 57,8			
	Noon		73 10	−23	.. ..	17 59,5			
	0 35	P. M.	73 00	−23					
	1 00		73 00	−23	.. ..	17 57,1			
	1 30		72 40	−23					
	1 40		73 00	−23					
	2 00		73 00	−22½	.....	17 55,2			
	2 30		73 10	−22½					
	2 45		73 00	−22					
	3 30		73 10	−22	.....	17 52,2	N.westerly Light	.....	Parhelion on each side of ⊙.
	3 50		74 45	−22					
	4 30		75 10	−22½	.....	17 50,1			
	+ 5 00		76 00	−22½	.....	17 45,3	.....	.....	*Max. westerly variation.*
	5 15		76 00	−22½					
	5 30		76 00	−23	.....	17 47,1			
	6 30		76 00	−23½					
	7 15		76 00	−23½	.....	17 50,1			
	8 10		76 00	−23½	.....	17 50,3	N. W.		
	9 00		75 55	−23½	.....	17 53	Mod.	Hazy	*Max. easterly variation.*
	9 30		75 40	−23½					

North end of Needle to the W. S. W.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrenᵗ. Inst.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibˢ.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 15th	10 10	P. M.	S 75 50W	—24	.....	17 55			
	11 00		75 40	—24	.....	17 56,7			
	11 46		75 40	—24	.....	17 56,5			
Mar. 16th	1 20	A. M.	74 5	—24	.....	17 57,5			
	1 50		74 00	—24	.....	17 57,7	N Westʸ. Mod.	Hazy low down	
	2 30		73 10	—24½					
	3 00		73 50	—24½	.....	18 00,3			
	3 45		73 40	—24½	.....	17 58			
	5 5		72 30	—24½	.....	18 0,2			
	5 50		72 10	—25	.....	17 58	Squally		
	6 20		72 10	—25					
	7 10		72 00	—24½	.....	18 0,2			
	7 25		71 55	—24½	.....	18 0,6			
	9 00		71 40	—24½	.....	18 1,5			
	9 30		71 30	—24½					
	10 00		71 30	—24	.....	18 1,5			
	10 30		71 20	—24					
	11 00		71 30	—24	.....	18 1,8			
	11 20		71 40	—24	.....	.....	.....	.....	It will be seen that the *max. deflections* of this needle, took place about the same time that a decrease & increase of intensity in the directive force of the horizontal needle took place. *Max. westerly var.*
	11 30		71 30	—24					
	Noon		71 30	—23	.....	17 56,6			
	0 5	P. M.	72 00	—23					
	0 15		73 00	—23					
	0 30		73 00	—23					
	0 45		72 30	—23					
	1 00		72 30	—23	.....	17 57			
	1 15		72 40	—23					
	1 30		73 20	—23					
	1 45		73 30	—23					
	2 00		73 30	—23	.. ..	17 58,8			
	2 10		73 20	—23	.. ..	.....	.....	.....	
	2 30		73 30	—23	.. ..	.....	N W Mod.	Hazy	
	2 56		73 30	—23					
	3 15		73 30	—23	.. ..	17 54,2			
	3 40		74 20	—23					
	5 15		75 10	—23½	.....	17 50,7			
	5 45		75 15	—23½	.....	17 46,6			
	+ 6 20		75 30	—23½	.....	17 45,3			
	6 45		75 30	—24					
	7 15		75 30	—24	.....	17 46,9			
	7 55		74 40	—24	.....	17 48,8			
	9 5		73 30	—24½	.....	17 54,5			
	9 50		73 25	—24½					
	10 20		73 00	—24½	.....	17 55,7			
	11 00		72 30	—24½	.....	17 55,8			
	11 30		72 00	—24½	.....	.....	Fresh NNW	Hazy	
	Midᵗ		72 00	—24½	.....	17 56,7			

To the left hand.

North end of Needle to the S 85° W. The line of minimum daily variation.

The distance of the nearest end of each magnet placed to the South, from the centre of the compass-box, was, of that attracting the North end of the needle 18,6 inches, and of the other attracting the South end of the needle 27,15 inches: under this adjustment, the needle made one vibration in 10,2 seconds, so that the directive power now, was to the undiminished force as 0,31 to 1. nearly.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 23d	6 30	A. M.	S 83 30W	—26	.....	18 2			*Max. easterly var.* took place at $2^h\ 5^m$ A. M.
	7 10		83 30	—26	.....	18 2,2			
	7 30		83 30	—26					
	7 55		83 30	—26	.....	18 1,5			
	+ 9 8		83 20	—26	.....	18 10,7			
	9 30		83 30	—26					
	10 10		83 30	—23	.....	18 10,5			
	10 30		83 30	—22					
	11 18		83 30	—22	.....	18 9,3			
	11 50		83 30	—21					
	0 4	P. M.	83 40	—21	.....	18 3			
	0 45		83 50	—20½					
	1 5		84 20	—20½	.....	17 52,8			
	2 5		84 20	—20	.....	17 53,9	Calm, clear and fine weather throughout the day.	.....	*Max. westerly var.*
	2 45		85 00	—19½					
	3 5		85 00	—19½	.....	17 56,5			
	3 25		85 00	—19½					
	3 55		85 00	—19½	.....	17 58,4			
	4 45		85 5	—19½	.....	17 55,6			
	5 20		85 00	—21					
	6 00		85 00	—22	.....	17 50,5			
	6 20		85 00	—23					
	7 00		85 10	—23½	.....	18 1,8			
	7 35		85 20	—24					
	7 55		85 20	—24	.....	17 56,7			
	9 00		86 00	—24	.....	18 0,2			
	— 9 15		86 20	—24					
	9 40		86 00	—24	.....	17 58,5			
	11 00		86 15	—25	.....	17 59			
	Midnr		85 50	—26½	.....	17 59			
Mar. 24th	1 00	A. M.	85 40	—26½	.....	18 00,8			
	1 30		84 40	—26½	.....	.....	Calm	Clear and fine	*Max. easterly var.*
	2 00		85 00	—27	.. To the right hand. ..	18 2,5			
	2 30		85 00	—27					
	2 40		84 00	—27					
	2 50		83 50	—26½	.. ..	18 2,5	Easterly Light	Ditto	
	3 20		83 40	—27					
	3 55		83 40	—27	.. ..	12 4,1			
	6 00		83 40	—27	.. ..	18 5,8			
	6 57		83 50	—27	.. ..	17 54,7	Calm	Clear and fine	

North end of needle to the S. 85° W. The line of min. daily variation.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 24th	7 50	A. M	S 83 50W	—27	.. ..	18 2			
	9 6		83 50	—26	.. ..	18 00			
	9 30		83 35	—26	.. ..	18 0,7	.....	.....	*Max. westerly var.*
	9 55		83 35	—26½	.. ..	18 6,9			
	+10 20		83 30	—26	.. ..	.....			
	10 50		83 30	—24½					
	11 00		83 40	—24½	.. ..	17 56			
	11 30		84 00	—23½					
	Noon		84 20	—23½	.....	17 49,1			
	0 15	P. M.	84 30	—23½					
	0 35		84 40	—22½					
	1 40		84 40	—22	.....	17 55,7	Easterly Light	Fine	
	2 10		84 55	—22					
	2 50		85 00	—22	.....	17 57			
	3 10		85 00	—22					
	3 42		Ditto	—22					
	4 11		.....	—22	.....	17 59,5			
	5 00		.....	—23	.....	17 54,5			
	5 50		.....	—24	.....	17 52,2			
	7 30		.....	—24					
	8 00		.....	—25	.....	17 55			
	8 30		.....	—25	....	17 50,2			
	8 52		.....	—26	.....	17 53,2			
	9 30		.....	—26½					
	9 55		.....	—27	.....	17 58,9			
	10 15		.....	—27					
	10 30		.. ..	—27½	.....	.....	Ditto	Ditto	
	11 10		.. ..	—27½	.....	18 1,4			
	Midnt		.. ..	—27	.....	18 1,1			
Mar. 25th	0 30	A. M.	.. ..	—27					
	1 6		.. ..	—27	.....	18 0,8	.....	.....	*Max. easterly var.*
	1 45		.. ..	—27	.....	17 55,8			
	2 10		.. ..	—27					
	2 42		.. ..	—27	.....	17 57,5			
	3 32		.. ..	—27					
	4 00		.. ..	—27	.....	17 59,5			
	4 28		.. ..	—27					
	5 40		.. ..	—29½	.....	17 57,2			
	6 57		.. ..	—29	.....	17 54,8			
	8 2		.. ..	—28	.....	17 57,9			
	8 50		.. ..	—28	.....	17 58,5			
	9 12		.. ..	—28	.. ..	17 59,5			
	9 50		.....	—28	.. ..	.....	.....	.....	*Max. westerly var.*
	10 14		.....	—26½	.. ..	18 0,8			
	11 00		.....	—26½	.. ..	17 58,3			
	11 30		.....	—26					
	Noon		.....	—26	.. ..	17 59,3			
	0 30	P. M.	.....	—26					
	0 55		.....	—26	.. ..	17 59,8			
	1 30		.....	—25					

No perceptible motion these 24 hours.

Very little motion.

Line of min. effect.

Light easterly winds and clear weather.

North end of needle to the S 85° W. The line of min. daily variation.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 25th	1 55	P. M.	S 85 00W	−24	.....	17 54,9			
	2 45		.....	−23½	.....	17 55,7			
	3 15		.....	−23½	.....	.....	.....	.....	*Max. easterly var.*
	3 50		.....	−23½	.....	17 56,7			
	4 50		.....	−23½	.....	17 54,3			
	6 00		.....	−26	.....	17 56,9			
	6 50		.....	−26	.....	17 56,2			
	7 36		.....	−26					
	8 30		.....	−26½	.....	17 57			
	9 00		.....	−26½	.....	17 57,5			
	10 00		.....	−26½	.....	17 56,3			
	11 00		.....	−27	.....	17 57,8			
	11 50		.....	−27	.....	17 58,3			
Mar. 26th	1 7	A. M.	.....	−26½	.....	17 57,7	N. W.	Hazy	
	1 50		.....	−26	.....	17 58,2	Fresh		
	2 15		.....	−26					
	3 00		.....	−26	.....	17 59,7			
	4 00		.. ..	−26	.. ..	17 59,4			
	4 50		.. ..	−27	.. ..	18 2,0	.....	Squally	
	6 00		.. ..	−26	.. ..	18 3,2			
	7 00		.. ..	−26	.. ..	18 3,7			
	7 40		.. ..	−26	.. ..	18 5,0			
	9 00		.. ..	−24					
	10 00		.. ..	−24	.. ..	18 7,5			
	10 25		.. ..	−24	.. ..	.....	.....	.....	*Max. westerly var.*
	11 2		.. ..	−23	.. ..	17 59			
	11 30		.. ..	−23					
	Noon		.....	−21½	.. ..	17 58,8	North		
	0 30	P. M.	.....	−22½			Mod.	Hazy	
	1 10		.....	−22	.....	17 52,5			
	1 50		.....	−22	.....	17 52,3			
	2 55		.....	−21¾	.....	17 57,6			
	3 50		.....	−22	.....	17 58			
	5 15		.....	−22½	.....	17 53,3	North		
	5 50		.....	−22½			Squally		
	6 20		.....	−22½	.....	17 54,5			
	7 10		.....	−23	.....	17 57,4			
	7 50		.....	−23	.....	17 56,7			
	9 5		.....	−23	.....	17 58,2			
	9 50		.....	−23	.....	17 57,2			
	10 50		.....	−23	.....	17 59,5	North	Clear	
	11 47		.....	−23	.....	17 59,8	Fresh		
Mar. 27th	1 00	A. M.	.....	−23	.....	18 1,0	.....	Hazy	
	1 30		.....	−23					
	1 55		.....	−23	.....	18 3			
	2 45		.....	−23					
	3 50		.....	−23	.....	18 4,2			
	5 15		.....	−23	.....	17 58,9	.....	.....	*Max. easterly var.*
	5 50		.....	−23	.....	18 00	Ditto	Clear	
	6 20		.....	−22					

No perceptible motion. Line of minimum effect.

North end of needle to the S. 85° W. The line of min. daily variation.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
	h. m.		° ′	°		m. s.			
Mar. 27th	7 10	A. M.	S 85 00 W	—22	.. ..	17 59,3			
	9 00		.. ..	—21	.. ..	17 57,3			
	9 30		.. ..	—21	.. ..	18 5,5			
	10 10		.. ..	—21	.. ..	18 4,7	.....	Hazy	
	10 45		.. ..	—20	.. ..	18 4,2		with snow	
	0 10	P. M.	.. ..	—20	.. ..	18 3,7			
	1 30		.. ..	—18	.....	17 57,2	.....	.....	*Max. westerly var.*
	2 10		.. ..	—18	.....	17 53,7			
	3 15		.. ..	—18½	.....	17 55,5			
	3 50		85 30	—18½	.....	17 56,5			
				—18½					
	7 00		86 00	—20	.....	17 57,8	.....	.....	Tried the electrometer, but no effects of electricity were observed by the gold leaf.
	9 12		86 30	—20	.....	17 55,3			
	9 35		86 20	—20	.....	.....	Westerly	Hazy	
	10 2		86 20	—20	.....	17 56	Light		
	10 35		86 20	—21					
	11 10		86 20	—21	.....	17 58,3			
	11 42		86 20	—21					
	Midnt		86 20	—22	.....	17 59			
Mar. 28th	1 8	A. M.	85 50	—22½	.....	18 1,6	Westerly	Hazy	*Max. easterly var.*
	1 50		85 20	—22½	.....	18 2,8	Light		
	2 30		84 40	—22½					
	3 5		84 00	—22½	.....	18 7,9			
	3 52		84 00	—22½	.....	18 6,0			
	6 30		83 20	—23	.. ..	17 58,5			
	7 00		83 20	—23	.. ..	18 7,2	Easterly	Clear and	
	7 30		83 20	—23	.. ..	17 55,7	Light	fine	
	9 10		83 00	—22	.. ..	18 3,7			
	9 30		82 30	—21½					
	9 56		82 00	—21½	.. ..	18 10,8			
	10 30		82 00	—20					
	11 00		81 40	—20	.....	18 10,4			
	+11 30		81 30	—20	.....	18 4,4			
	1 00	P. M.	83 30	—18	.....	18 1	... ..	.....	*Max. westerly var.*
	1 15		85 30	—18					
	1 30		85 30	—18					
	1 40		85 00	—18					
	2 00		85 00	—18	.....	18 2,5			
	2 30		66 50	—18					
	2 50		87 00	—18	.....	17 56,2			
	3 22		87 00	—18					
	3 45		87 00	—18					
	5 30		88 00	—18	.....	17 51,5			
	6 00		88 10	—18	.....	.....			
	6 30		87 30	—19½	.....	17 53,3			
	7 00		87 30	—20	.....	.....	Ditto	Hazy	
	9 5		87 30	—20½	.....	17 52,8		with snow	
	9 50		87 30	—20½	.....	17 56,3	.....	.....	*Max. easterly var.*
	10 20		87 30	—20½					
	10 50		87 20	—20½	.....	17 57,8			

No perceptible motion whatever. Line of min. effect. To the right hand.

North end of Needle to the S. 85° W. The line of min. daily variation.

Date.	Mean Time of Obser-vation.	A. M. or P. M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
	h. m.		° ′	°		m. s.			
Mar. 28th	11 15	P. M.	S 86 10W	—20½	.....	17 57,5			
	11 52		86 00	—21	.....	17 58,8			
Mar. 29th	1 7	A. M.	86 10	—21	.....	17 59,3	East	Hazy	
	1 52		86 20	—21	.....	18 0,5	Light		
	2 12		86 10	—21					
	2 50		86 10	—22	.....	18 2,3			
	3 45		86 10	—22					
	4 12		86 10	—22	.....	18 3,5			
	5 00		85 45	—23	.....	18 3,3			
	5 30		84 30	—23					
	7 00		84 50	—23	.....	17 57,5			
	7 30		84 50	—23	.....	18 4,7			
	9 10		84 40	—21	.....	18 0,8	.....	.....	Halo and Parhelion on each side side of ⊙. *Max. westerly var.*
	9 46		84 30	—21	.....	17 57,5			
	10 12		84 20	—21	.....	17 51,2	Ditto	Ditto	
	11 5		85 10	—20	.....	18 14,3			
	11 40		84 40	—19					
	0 7	P. M.	84 10	—19	.....	18 18			
	+ 1 2		84 00	—18½	.....	17 46,7			
	1 40		84 00	—18	.....	.....	.....	.....	*Mvx. easterly var.*
	2 15		84 10	—17½	.....	17 48,5			
	2 50		84 40	—17½					
	3 15		85 00	—17½	.....	17 48			
	3 55		85 00	—17	.....	17 56,2			
	6 00		85 15	—19½	.....	17 55,5	Easterly	Clear and	
	7 00		85 30	—21	.....	17 53	Light	fine	
	7 30		85 30	—21					
	8 00		85 40	—22	.....	17 59,3			
	8 30		85 40	—22					
	8 50		85 40	—22					
	— 9 12		86 30	—22	.....	17 58,5			
	10 14		86 30	—22	.....	17 59,7			
	10 46		86 20	—22					
	11 20		86 20	—22	.....	18 1,3			
	Midnᵗ		86 00	—22	.....	18 2,8	Northerly	Clear	
Mar. 30th	0 8	A. M.	85 10	—22	.....	.....	North	Clear	
	0 10		84 25	—22			Light		
	1 20		84 25	—22	.....	18 0,3			
	2 35		82 40	—22	.....	18 9,3			
	3 10		82 30	—22½	.....	18 14,8			
	3 58		77 30	—23	.....	18 31,3			
	+ 5 00		75 00	—23½	.....	18 24,2	.....	.....	
	6 00		78 28	—23½	.....	18 11,5			
	6 10		79 00	—23½					
	6 40		78 30	—23½					
	7 00		78 00	—23½	.....	18 13,5	Easterly	Clear and	
	7 15		79 00	—23½			Light	fine	
	7 20		80 00	—23½					
	7 30		81 00	—23					
	8 00		81 00	—23	.....	18 11,4			

To the right hand.

North end of Needle to the S 85° W. The line of min. daily variation.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Mar. 30th	10 00	A. M.	S 83 30W	—21	.....	18 10,3	.....	Hazy	*Max. westerly var.*
	10 10		85 00	—21					
	10 30		80 20	—21					
	10 50		83 30	—20½	.....	17 46,7			
	11 20		88 40	—19					
	11 40		88 00	—19					
	Noon		85 00	—19	.....	17 54			
	0 50	P. M.	88 00	—19					
	1 10		88 10	—18	.....	18 11,3			
	1 48		88 00	—18					
	2 36		87 40	—17	.....	17 57,2			
	— 3 00		89 10	—17	.....	17 57			
	5 10		88 30	—18½	.....	17 58,1			
	5 45		87 40	—19	.....	17 53,7			
	6 15		87 10	—20					
	6 50		86 50	—21	.....	17 54,1	Easterly moderate	Hazy	
	7 20		86 40	—21					
	8 00		86 40	—21	.....	17 58,4			
	8 30		86 40	—21					
	8 45		86 00	—21					
	9 12		86 00	—22	.....	17 55,2			
	9 42		86 20	—22					
	10 15		86 30	—22	.....	17 57,2			
	10 50		86 30	—22					
	11 50		86 30	—22					
	Midnt		86 30	—22	.....	17 57,7	Ditto	Ditto	
Mar. 31st	5 10	A. M.	81 00	—24	.....	18 0,7	Easterly	Hazy	*Max. easterly var.*
	5 50		81 00	—24	.....	.....	Fresh		at 1h 3m A. M.
	6 20		80 40	—24	.. ..	18 9,4			
	+ 6 55		80 30	—24					
	7 15		81 00	—24	.. To the left hand. ..	18 4,4			
	8 00		83 20	—24	.. ..	17 55,8			
	9 6		83 50	—23	.. ..	18 3	Ditto	Cloudy	
	10 0		84 30	—22	.. ..	18 4,3	Light		
	11 5		83 10	—21	.. ..	18 9,2			
	11 36		83 00	—21					
	Noon		85 50	—21	.. ..	18 1	.....	.....	*Max. westerly var.*
	— 0 30	P. M.	86 30	—21	.....	.....	Easterly		
	1 10		86 20	—20	.....	17 58,8	moderate		
	1 50		86 20	—20					
	2 15		86 20	—19½	.....	17 53,7			
	2 50		86 20	—19½					
	3 12		86 20	—19½	.....	17 58,5			
	3 56		86 20	—19½	.....	17 58,2			
	8 00		86 20	—23	.....	17 56,5	Easterly	Very Clear	
	9 00		86 30	—24	.....	17 57,7			
	9 56		84 55	—24	.....	17 55,5	.....	.....	☽ on south meridian 19° altitude.
	10 30		84 55	—24½					
	11 00		85 00	—25	.....	17 56,5			
	Midnt		85 15	—25	.....	18 1			

North end of Needle to the S 85° W. The line of min. daily variation.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
April 1st	1 15	A. M.	S 84 20W	−25½	.....	18 3,5	Easterly		
	1 52		84 30	−25½	.....	.....	moderate	Clear	
	2 18		84 20	−26	.....	18 9,7			
	2 50		84 00	−26	.....	18 15,5			
	3 20		84 00	−26½					
	3 56		84 00	−26½	.....	18 4	Squally	.....	*Max. easterly var.*
	6 00		82 30	−27	.....	18 10,8	Moderate	Fine and	
	6 15		82 00	−27			easterly	Clear	
	6 30		80 30	−27					
	6 45		79 30	−27					
	7 00		79 20	−27	.....	18 15			
	9 10		78 50	−24	.....	18 23,3			
	+ 9 50		78 00	−23					
	10 15		81 30	−23	.....	18 9			
	10 45		83 20	−23					
	11 6		87 10	−23	.. Irregular. ..	17 55,3	.....	.....	The intervals of 10 vibˢ of the horizontal needle were rapidly decreasing between 11ʰ and 12ʰ A.M.
	11 20		90 00	−22					
	11 32		90 00	−22					
	11 45		87 30	−21	.. ..	.....	Easterly	Clear and	
	0 8	P. M.	87 20	−20½	.. ..	17 49,8	light	Fine	
	1 00		83 30	−20	.....	17 49,7			
	1 49		90 00	−19	.....	17 43,8	.....	.....	*Max. westerly var.*
	2 30		89 20	−19					
	3 12		88 15	−19	.....	17 55,7			
	4 00		87 30	−19	.....	17 54,3			
	5 00		88 50	−21	.....	17 44			
	6 00		87 00	−21	.....	17 55			
	6 30		85 00	−21					
	7 30		87 40	−23	.....	17 45			
	8 00		88 00	−23	.....	17 52,3			
	− 9 6		91 50	−23½	.....	17 39,3			
	10 40		89 30	−23½	.....	17 46,1			
	11 5		86 20	−23½	.....	17 52,9	Easterly	Clear and	*Max. easterly var.*
	11 52		85 30	−25	.....	17 59,1	light	Fine	
Apr. 2nd	1 00	A. M.	84 30	−26	.....	18 5,8	Easterly	Ditto	
	1 32		83 50	−26			moderate		
	2 10		83 20	−26	.....	18 4,7			
	2 42		82 50	−27					
	3 5		82 00	−27	.....	18 4,5			
	+ 4 2		81 40	−27	.....	18 8,8			
	5 00		82 00	−27	.....	18 57,3			
	6 00		82 10	−26½	.....	17 53,5			
	8 00		———	−26½	———	18 17,5			
	9 10		82 40	−24	.. ..	18 0,7			
	9 47		83 00	−24	.. To the left hand. ..	.....	Ditto	Hazy	
	10 12		83 30	−24	.. ..	17 57,5			
	11 5		84 20	−23	.. ..	17 56			
	11 10		85 00	−23					
	11 45		85 00	−23	.. ..	17 33,8	Squally	.....	*Max. westerly var.*

North end of Needle to the S 85° W. The line of min. daily variation.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
April 2d	1 4	P. M.	S 86 40W	—23	.....	17 46			
	1 30		87 30	—22½					
	— 1 50		88 00	—22½					
	2 15		88 00	—22½	.....	17 47,4			
	2 50		88 00	—22					
	3 12		88 00	—22	.....	17 53,6			
	3 55		87 20	—22	.....	17 56			
	5 6		86 30	—23	.....	17 53,5			
	6 00		84 50	—23	.....	17 59,8	Easterly Light	Hazy to the westward.	
	7 5		84 50	—23½	.....	17 54,7			
	—		—	—23½	—	—			
	9 5		85 45	—23	.....	17 53,7			
	10 2		86 10	—23	.....	17 56,5			
	10 50		86 10	—23	.....	17 57			
	Midnᵗ		86 10	—24	.....	17 58	.....	.....	*Max. easterly var.*
April 3d	1 12	A. M.	84 00	—24	.....	18 5,1	Ditto	Hazy	
	1 55		83 30	—24					
	2 35		83 30	—24½	.....	18 1,2			
	3 10		83 20	—24½	.....	18 5,2			
	3 50		82 30	—24½	.....	18 11,3			
	—		—	—24½	—	—			
	+ 9 00		77 20	—23					
	9 30		79 00	—23	.. ..	.....	.....	.....	*Max. westerly var.*
	10 5		82 30	—22	.. ..	18 11			
	10 48		81 10	—22	.. ..	18 4,3			
	11 22		80 10	—21½					
	0 10	P. M.	82 30	—21	.. ..	17 57,5			
	0 13		87 00	—21					
	0 15		87 24	—21					
	1 6		90 30	—21	.. ..	17 45,7			
	— 1 40		91 5	—20					
	3 00		86 55	—19	.....	17 56,4	Easterly Light	Hazy with small snow.	
	3 30		86 00	—18	.....	18 00,5			
	5 2		86 00	—19	.....	17 54,3			
	5 30		86 30	—19½					
	6 00		87 00	—19½	.....	17 51,9			
	6 25		87 00	—20					
	6 50		87 00	—20	.....	17 54,3			
	7 20		86 30	—20½					
	7 54		86 10	—21	.....	17 55,1			
	9 10		86 30	—21	.....	17 55,5			
	10 2		86 20	—21	.....	17 57,3			
	11 15		86 20	—22	.....	17 58,7			
	Midnᵗ		86 20	—22	.....	17 58,6	.....	.....	*Max. easterly var.*
Apr. 4th	5 20	A. M.	85 00	—23	.....	17 56,0	Ditto	Hazy	
	5 50		85 00	—23					
	6 15		84 30	—23	.....	18 0,4			
	6 52		84 00	—23					
	7 00		84 00	—23	.....	18 2,7			
	7 10		83 00	—23					

To the left hand.

North end of Needle to the S 85° W. The line of minimum daily variation.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
April 4th	+ 9 10	A. M.	S 82 00 W	—21	.. .	18 12,3			
	9 52		83 40	—21					
	10 15		84 50	—21	.. ..	18 1,5			
	11 5		85 30	—21	.. ..	18 1,5			
	0 5	P. M.	85 40	—19	.. ..	18 2	....	....	*Max.westerly var.*
	— 1 10		91 00	—18	.. ..	17 43,5			
	1 20		91 00	—18	To the left hand.				
	1 50		89 10	—18					
	2 10		89 00	—18	.....	17 45,4	....	....	*Max.easterly var.*
	2 45		89 00	—18					
	3 8		86 50	—18	.....	17 58,1			
	3 25		86 50	—17	.....	.....	Easterly light	Clear and fine.	
	3 54		86 10	—17	.....	18 2,7			
	5 00		86 10	—18	.....	18 00			
	5 30		86 30	—18					
	6 00		86 30	—19½	.....	17 55			
	7 00		86 30	—20	.....	17 54			
	9 00		86 30	—22	.....	17 54			
	9 55		86 30	—23					
	10 15		86 25	—23	.....	17 56,2			
	11 00		86 25	—23					
	11 16		86 25	—23	.....	17 57,4			
	11 50		86 00	—23	.....	18 0,3			
April 5th	1 7	A. M.	86 00	—24	.....	18 2,3			
	2 5		85 40	—24	.....	18 2,8			
	3 0		85 30	—25	.....	18 3,3	Easterly light	Clear and fine.	
	4 2		85 00	—25	.....	18 7,5			
	5 30		85 00	—25	.....	17 58			

North end of Needle to the N 85° E.

Both magnets were placed to the south of the compass; the distance from the centre of the box, to the nearest end of the magnet, attracting the north end of the needle, was 18,98 inches, and to the nearest end of the other, attracting the south end of the needle, 27 inches. The needle now made 1 vibration in 9,5 seconds, the directive force being reduced in the ratio of 0,35 to 1 nearly.

April 5th	6 00	A. M.	N 85 0 E	—25	.....	17 59,5	Easterly light	Clear and fine.	⊙ rising ENE. (true.)
	7 00		85 10	—25	.....	18 6,2			
	7 30		84 30	—25	.....	18 1,5			
	8 56		84 00	—22	.. ..	18 1,8			
	9 15		83 50	—22½	.. ..	18 1			
	9 30		83 20	—21½	.. ..	.....	....	....	*Max.westerly var.*
	10 00		82 30	—21½	.. ..	18 0,2			
	10 15		84 30	—21	To the right hand.				
	10 50		86 00	—20					
	11 00		85 30	—20	.. ..	18 6,4			
	11 30		84 30	—19					

North end of Needle to the N 85° E.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
April 5th	11 35	A. M.	N 83 00 E	—19					
	11 40		82 00	—19					
	11 50		81 00	—19					
	11 55		80 30	—19	.....	.....	.....	Slight fall of small snow.	
	Noon		80 00	—19	.....	17 47,6			
	+ 0 45	P. M.	79 50	—18					
	1 00		79 50	—18	.....	17 51,6			
	1 30		80 00	—18					
	2 00		80 00	—18	.....	17 56			
	2 30		80 30	—18½					
	2 40		79 50	—17	.....	17 55,2			
	3 30		80 50	—17					
	3 58		81 50	—17	.....	17 57,1			
	5 30		82 00	—20	.....	17 55,8			
	6 00		81 50	—21	.....	17 55			
	7 00		81 50	—21	.....	17 50			
	9 00		81 40	—23	.....	18 2,2			
	9 45		81 40	—23					
	10 20		81 40	—23½	.....	18 2,9			
	10 50		81 50	—23					
	11 15		82 10	—24	.....	18 00			
	11 54		82 40	—24	.....	18 1,6	.....	.....	*Max. easterly variation.*
April 6th	1 5	A. M.	83 00	—25	.....	18 6,8	Easterly light.	Clear and fine	
	1 55		83 25	—25					
	2 5		83 50	—25	.....	18 6,2			
	2 7		84 00	—25					
	3 0		84 10	—26	.....	18 9,3			
	3 50		84 25	—26	.....	17 54,4			
	5 6		84 35	—26	.....	18 3			
	5 58		85 10	—26	.....	18 7,8	ENE		
	7 10		85 30	—26	.....	18 9,7	mod. & clear		
	7 15		87 00	—26					
	— 7 30		87 30	—26	.....	.....	Easterly		
	7 55		87 30	—25	.....	18 15,5	light		
	9 00		87 30	—23½	.....	18 11,8			
	9 30		87 20	—23½					
	10 00		87 10	—22	.....	18 9,2	.....	.....	*Max. westerly variation.*
	10 30		87 30	—22					
	11 00		87 30	—22	.....	18 2,6			
	11 35		87 20	—21					
	Noon		87 20	—20	.....	18 9			
	0 30	P. M.	87 10	—19					
	0 40		85 40	—19					
	1 00		84 50	—19½	.....	17 56,1			
	1 30		84 50	—19½					
	1 55		84 40	—19½	.....	17 59			
	2 15		84 40	—19½	.....	.....	Easterly	Clear and	
	2 50		84 40	—19½			light	fine	
	3 15		84 30	—19½	.....	18 0,4	.....	.....	*Max. easterly variation.*
	3 56		84 10	—19½	.....	18 1,7			

To the left hand.

North end of Needle to the N 85° E.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
April 6th	5 10	P. M.	N 84 10 E	—20	.....	18 1,8			
	6 6		84 00	—21	.....	17 56			
	6 50		84 10	—21	.....	17 56,7			
	7 48		84 20	—22	.....	17 55,7			
	+ 9 00		83 30	—22	.....	18 3,3			
	10 00		83 30	—23	.....	18 0,3			
	10 30		83 30	—24					
	11 00		83 30	—24	.....	18 00	Easterly light	Clear and fine.	
	11 30		83 30	—24					
	Midt.		83 30	—24½	Irregular.	18 2,5			
April 7th	1 10	A. M.	83 30	—25	Irregular.	18 1,1	Easterly light	Clear and fine.	
	1 50		83 30	—25	Irregular.	18 4,6			
	2 30		83 30	—25					
	3 3		83 30	—25	.....	17 58,7			
	3 50		84 00	—25	.....	17 58,5			
	5 00		84 20	—25	.....	17 56,6			
	6 00		84 15	—25	.....	18 0,7			
	7 00		84 35	—24	.....	18 6,1			
	— 7 55		84 55	—23	.....	18 1,2			
	9 10		84 30	—23	.....	18 5			
	9 50		84 30	—22	.....	18 6,5			
	10 11		84 30	—21					
	11 2		84 30	—20	.....	18 7,2			
	11 51		84 30	—19					
	Noon		84 30	—18½	To the right hand.	18 8	Ditto	Ditto	
	0 30	P. M.	84 30	—17½	To the right hand.				
	1 00		83 30	—17	To the right hand.	17 55,2			
	1 30		82 20	—16½					
	2 00		82 00	—16½	To the right hand.	17 53,5	.....	.....	*Max. westerly var.*
	2 30		81 30	—16½					
	3 00		81 30	—16½	To the right hand.	17 57			
	5 00		81 25	—17	To the right hand.	17 53			
	5 30		81 10	—18					
	+ 6 10		81 5	—19	.....	17 52,8			
	6 30		81 5	—19					
	7 10		81 5	—20	.....	17 52,6			
	7 30		81 10	—20					
	7 52		81 35	—20					
	7 55		81 40	—20	.....	17 56,6			
	9 10		81 50	—20	.....	18 1,8			
	10 6		82 00	—21	.....	17 59,7			
	11 10		82 20	—21	.....	18 1,5			
	11 56		82 15	—22	.....	18 1,5			
April 8th	1 00	A. M.	83 30	—22	.....	17 59	Easterly light	Clear and fine	*Max. easterly var.*
	1 10		84 30	—22					
	1 40		84 30	—22½					
	2 10		85 00	—22	.....	18 9			

North end of Needle to the NE.

The magnets were now placed to the north and south of the needle, with their axes slightly inclined to the magnetic meridian; the north magnet had its north pole towards the compass-box, at the distance of 29,1 inches from its centre, and the south magnet had its south pole towards the compass-box, at the distance of 30,1 inches from its centre: the time in which the needle now performed 1 vibration, was 14,4 seconds; so that the directive force was reduced in the ratio of 0,15 to 1.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
April 8th	5 10	A. M.	N 45 30 E	—23	.....	18 1,3	East Fresh	Clear and Fine	It will be seen that, at the time of the greatest *westerly var.* an increase of directive power in the horizontal needle took place, which accounts for the great expression of 50° for the daily variation.
	5 55		45 20	—22					
	6 30		45 20	—22	.....	18 9,2			
	6 55		45 20	—22					
	7 20		45 20	—21½	.....	18 12,3			
	7 50		44 10	—21½					
	8 00		43 50	—21½	.....	18 3,4			
	9 26		42 20	—20	.....	17 58,8			
	9 28		42 00	—20	.. To the right hand. ..	18 22,8			
	10 10		41 50	—20					
	10 30		41 30	—20					
	11 10		41 10	—19	.. ..	18 6			
	11 30		41 00	—18½					
	Noon		36 10	—18½	.. ..	17 51,8			
	0 15	P. M.	35 00	—18½					
	0 30		29 00	—18½					
	+ 1 10		1 30	—17	.....	17 56,2	.....	.....	*Max. west. var.*
	2 00		10 10	—17	.....	17 50,5			
	2 50		16 30	—17					
	3 10		17 00	—17	.....	17 44	Ditto moderate	Clear and Fine	
	3 47		17 40	—17	.....	17 53			
	5 5		25 30	—17	.....	17 43,5			
	5 30		25 30	—17					
	6 00		27 30	—17	.....	17 37			
	6 20		27 30	—18					
	6 35		32 00	—19					
	7 10		33 30	—19	.....	17 41,5			
	8 00		37 00	—19	.....	17 34,7			
	9 30		40 00	—20	.....	17 44,6			
	10 00		40 00	—20	.....	17 45,4			
	10 35		40 00	—20					
	11 12		45 10	—20½	.....	.....	Easterly Light	Hazy	*Max. east. var.*
	—Midnt		51 30	—20½	.....	.....			

North end of Needle to the N E.

The situation of the magnets, in this case, was the same as in the preceding observations at N.E; except that their ends nearest to the needle were 29,7 inches from the centre of the compass-box: the needle making 1 vibration in 12 seconds, the directive force was reduced in the ratio of 0,22 to 1.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Apr. 9th	1 00	A. M.	N 54 00 E	—20¼	.....	18 4	Easterly moderate	Hazy	
	2 00		54 00	—20½	.....	17 7,3			
	3 12		53 50	—20½	.....	18 8,2			
	3 48		53 50	—21					
	4 8		53 30	—20	.....	18 7,5			
	5 00		53 00	—20	.....	18 12			
	6 00		52 00	—20	.....	18 8			
	6 30		51 30	—20					
	7 00		51 00	—20	.....	18 8,2			
	7 30		50 40	—20	.....	18 7,5			
	9 00		50 20	—18½	.....	18 9,7			
	9 35		44 50	—18½	.....	.....	Ditto	Overcast	
	9 50		44 10	—18½	.....	18 9,2			
	10 15		44 10	—18					
	10 45		44 00	—17½					
	11 10		44 00	—17	.....	18 16,1			
	11 45		43 40	—17					
	12 8	P. M.	43 00	—16½	.....	18 9,7			
	1 5		38 55	—16	.....	17 58,5	.....	.....	*Max. westerly var.*
	1 30		38 40	—16					
	2 10		38 30	—16	.....	17 53,9			
	2 30		38 15	—15					
	3 10		38 00	—16	.....	17 47,8			
	+ 3 50		34 00	—16	.....	17 41,4			
	5 00		34 00	—17	.....	17 41,5			
	6 00		34 00	—17	.....	17 55			
	6 30		34 00	—17					
	7 00		34 00	—17	.....	17 43			
	8 00		34 00	—17	.....	17 50,2			
	9 10		34 20	—18½	.....	17 47,2			
	9 45		35 20	—19					
	10 5		35 30	—19	.....	17 54,4	Easterly moderate	Hazy	
	10 35		35 50	—19½					
	11 7		36 00	—19	.....	17 55,4			
	11 34		36 30	—19					
	11 56		37 30	—19	.....	17 56,5			

To the right hand.

North end of Needle to the N E.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahrent. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		o ′	o		m. s.			
Apr. 10th	1 13	A. M.	N 42 50 E	—19	.....	17 57,5	Easterly moderate	Hazy	
	1 15		44 50	—19					
	1 16		45 30	—19					
	1 17		46 00	—19					
	1 58		47 00	—18½					
	2 11		47 30	—18½	.....	18 3,8			
	2 55		51 40	—18	.....	18 11	.....	.....	*Max. easterly var.*
	— 3 50		53 00	—18	.....	18 4,4			
	5 10		52 20	—18	.....	18 14,5			
	6 4		52 20	—18	.....	18 13,3			
	7 2		52 40	—17	.....	18 17,7			
	7 50		52 20	—17					
	8 10		52 20	—16	.. To the right hand. ..	18 20,2			
	9 00		52 00	—16	.. ..	18 7,2	Easterly Fresh	Thick hazy weather with snow drift.	
	10 00		51 00	—16	.. ..	18 10			
	10 30		46 30	—15½					
	11 00		41 00	—15	.. ..	17 53,5			
	11 30		40 00	—14½					
	+Noon		38 40	—14½	.. ..	17 58,5			
	1 00	P. M.	39 00	—14	.. ..	17 55,6			
	1 32		40 20	—14					
	2 00		40 20	—14	.....	18 3,5	.....	.....	*Max. westerly var.*
	2 32		40 20	—13½	.....	.....	E S E Strong	Much snow drift and thick weather.	
	3 00		39 40	—13½	.....	17 37,9			
	3 34		39 00	—13½					
	3 55		39 00	—13½	.....	17 48,2			
	5 7		39 00	—13	.....	17 56,8			
	6 6		39 10	—13	.....	17 59,2			
	7 5		39 10	—13	.....	17 58,7	ESE strong gales with heavy drift of snow.		
	7 46		39 00	—13	.....	18 0,5			

The direction of the Needle was not registered after $7^h\ 46^m$ P. M. in consequence of the severity of the weather: Gale of wind from eastward, and much snow drift.

North end of Needle to the S. E.

The needle was held in equilibrio at this point by two bar magnets; one to the North, with its nearest end from the centre of the compass 26,3 inches; the other to the South, having its nearest end from the centre of the compass 26,6 inches; the axis of each magnet was slightly inclined to the meridian, and the needle under their influence made 1 vibration in 11,½ seconds, the directive power being reduced in the ratio of 0,24 to 1 nearly.

Date.	Mean Time of Observation.	A.M. or P.M.	Reading of north end of needle.	Temp. Fahrenᵗ. Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &c.
1825.	h. m.		° ′	°		m. s.			
Apr. 12th	6 30	A. M.	S 44 00 E	+ 3	.....	18 17,4	E S E	Hazy	*Max. easterly var.*
	7 00		43 30	+ 3½			Fresh		took place at
	8 00		43 10	+ 4	.....	18 20,3			$0^h\ 3^m$ A. M.
	9 32		43 00	+ 5	.....	18 16,5			
	10 15		42 55	+ 6	.....	18 19,6			
	10 32		42 30	+ 6					
	11 7		42 30	+ 6	.....	18 12,2			
	11 30		42 10	+ 7	.....	.....	East	Snow	
	11 32		42 00	+ 7	.....		moderate	falling	
	11 33		41 55	+ 7					
	0 5	P. M.	41 55	+ 7	.....	18 12,8			
	1 10		42 00	+ 6	.....	18 10,3	.....	.....	*Max. westerly var.*
	2 7		42 00	+ 5	.....	18 8,7			
	+ 3 8		41 50	+ 5	.....	18 8,2	Squally	Much	
	3 57		41 50	+ 5	.....	18 6,2		drift	
	5 00		42 10	+ 5	.....	17 59,7			
	5 30		42 40	+ 5					
	6 00		42 40	+ 5	.....	18 1,7			
	6 30		42 40	+ 5					
	7 00		42 40	+ 4	.....	17 56,3			
	8 00		42 40	+ 4½	.....	17 58			
	10 2		50 30	+ 4	.....	18 7	Eastward	Stars	
	11 10		50 30	+ 4	.....	18 6,2	Squally	faintly	
	11 55		50 30	+ 4	.....	18 11		visible	
Apr. 13th	1 7	A. M.	50 0	+ 3	.....	18 14	Easterly	Cloudy	
	2 5		49 30	+ 2	.....	18 14,5	moderate		
	3 6		50 30	+ 1	.....	18 16,7			
	— 4 0		51 30	— 1	.....	18 18,5			
	5 30		49 5	— 1	.....	18 22,8			
	6 00		48 30	— 1	.....	18 21,5	Easterly	Fine,	*Max. easterly var.*
	6 30		48 00	— 1			Light	clear.	
	7 00		47 00	Zero	.....	18 24,8	N E		
	7 30		46 20	Zero	.....	.....	Squally		
	8 00				.....	18 28,5	with drift		
	9 00		44 00	+ 0½	.....	18 25,8			
	9 50		43 50	+ 0½					
	10 10		41 00	Zero	.....	18 23,1			
	10 30		36 00	Zero					
	+ 11 10		35 40	+ 1	.....	18 21,2			
	11 30		36 5	+ 1	.....	18 11,8			
	1 5	P. M.	37 00	+ 1	.....	18 8,4	Northerly	Hazy	
	1 30		37 00	+ 1	.....	17 58,6	Fresh	.....	*Max. westerly var.*

To the left hand.

North end of Needle to the S E.

Date.	Mean Time of Observation.	A. M. or P. M.	Reading of north end of Needle.	Temp. Fahre n / Instr.	Direction of north end of needle during westerly daily variation.	Time that a horizontal needle took to make 60 vibrations.	Winds.	Weather.	Remarks, &e.
1825.	h. m.		o ,	o		m. s.			
Apr. 13th	2 15	P. M.	S 37 00 E	+ 1	.....	17 59			
	3 30		37 00	Zero	.....	17 55,6			
	5 30		44 30	— 2	.....	17 54	N. by E.	Hazy	
	6 00		46 00	— 2	.....	17 59,5	Fresh	with drift	
	6 15		47 10	— 2	.....	17 56,5			
	— 6 30		50 00	— 2					
	7 00		50 00	— 4	.....	17 58,5	Ditto	Ditto	
	7 30		50 00	— 4					
	9 5		49 30	— 5½	.....	18 2,5			
	9 45		49 00	— 6½					
	10 10		47 20	— 7	.....	18 5,6			
	11 00		47 20	— 7	.....	18 2,5			
	11 30		47 10	— 7	.....	.....	Fresh	Cloudy	
	Midnt		47 00	— 7	.....	18 3,3	North	overcast	
Apr. 14th	1 10	A. M.	46 30	— 7½	.....	18 14,0	E S E	Cloudy	
	1 30		46 20	— 8			Fresh		
	2 10		45 10	— 8	.....	18 20,8			
	3 7		44 10	— 9	.....	18 22,8	Squally	Thick with drift, zenith clear	*Max. easterly variation.*
	3 50		43 55	— 9	.....	18 5,7			
	5 10		43 40	— 9	.....	18 22,7			
	6 00		43 40	— 9	.....	18 14,5			
	7 10		43 40	—10	.....	18 8,8			
	7 35		43 40	—10					
	7 50		43 20	—10	.. To the left hand. ..	18 6			
	9 30		41 30	— 9	.. ..	18 2,7	N. Easterly	Hazy	
	10 00		38 40	— 9	.. ..	18 18,5	Squally		
	10 30		38 30	— 9					
	11 00		43 30	— 9	.. ..	17 56			
	11 30		44 40	— 8					
	0 5	P. M.	37 50	— 6	.. ..	18 5			
	0 20		30 00	— 6					
	0 30		28 45	— 6	.....	.....	.....	. ..	*Max. westerly variation.*
	+ 0 48		25 10	— 5½					
	1 20		35 10	— 5½	.....	17 57			
	2 00		39 00	— 5	.....	18 2			
	2 30		32 10	— 4					
	3 00		38 20	— 4	.....	17 48			
	4 00		39 30	— 4	.....	17 48,2			
	5 10		42 00	— 4	.....	17 40,5			
	5 50		51 10	— 5	.....	17 26,8			
	6 50		49 30	— 6	.....	17 35,7	Northerly	Hazy	
	7 10		50 20	— 7			Squally	low down	
	7 48		51 00	— 8	.....	17 25,2			
	9 30		52 30	— 8	.....	17 44			
	10 00		57 10	— 8	.....	17 50,7			
	—10 30		62 00	— 9					
	11 00		59 30	— 9	.....	18 00	.....	.....	*Max. easterly variation.*
	11 30		58 20	— 9					
	11 40		56 20	— 9	.....	.....	Fresh and	Clear	
	Midnt		54 00	— 9½	.....	18 6,5	Squally	over head	

March 22nd. North end of Needle to the S. 83° W.

THE following summary of the observations at this point, is given here, merely to prevent breaking the preceding series: they were commenced at 6 o'clock in the morning, at which time the north end of the needle was at S. 83° 30′ W. where it remained until $\frac{1}{2}$ past 9^h; it then moved to S. 85° W. and became nearly stationary until about $11^h\ 30^m$, at which time it was at S. 81° 30′ W. and soon after, I observed it vibrating rapidly in very small arcs, which were continued with different degrees of intensity for the space of a quarter of an hour. During this time, simultaneous observations on the times of vibration of a horizontal needle were made, and as great fluctuations were observed in the intervals of 10 vibrations, I have inserted them in detail, as follows, in order to show the variations of horizontal intensity which take place in short intervals, and to which must be attributed the irregular vibratory motion observed in this needle.

Mean Time of Observation.	Intervals of 10 vibrat.	Remarks.
h. m. s.		
11 38 5,2	m. s.	
41 10	3 4,8	It appears by these observations, that the intervals of 10 vibrations, exhibit changes of horizontal intensity to the amount of $\frac{1}{59}$th part of those intervals, in the space of quarter of an hour.
44 13	3 3	
47 16,5	3 3,5	
50 19	3 2,5	
53 20,7	3 1,7	
56 22,5	3 1,8	

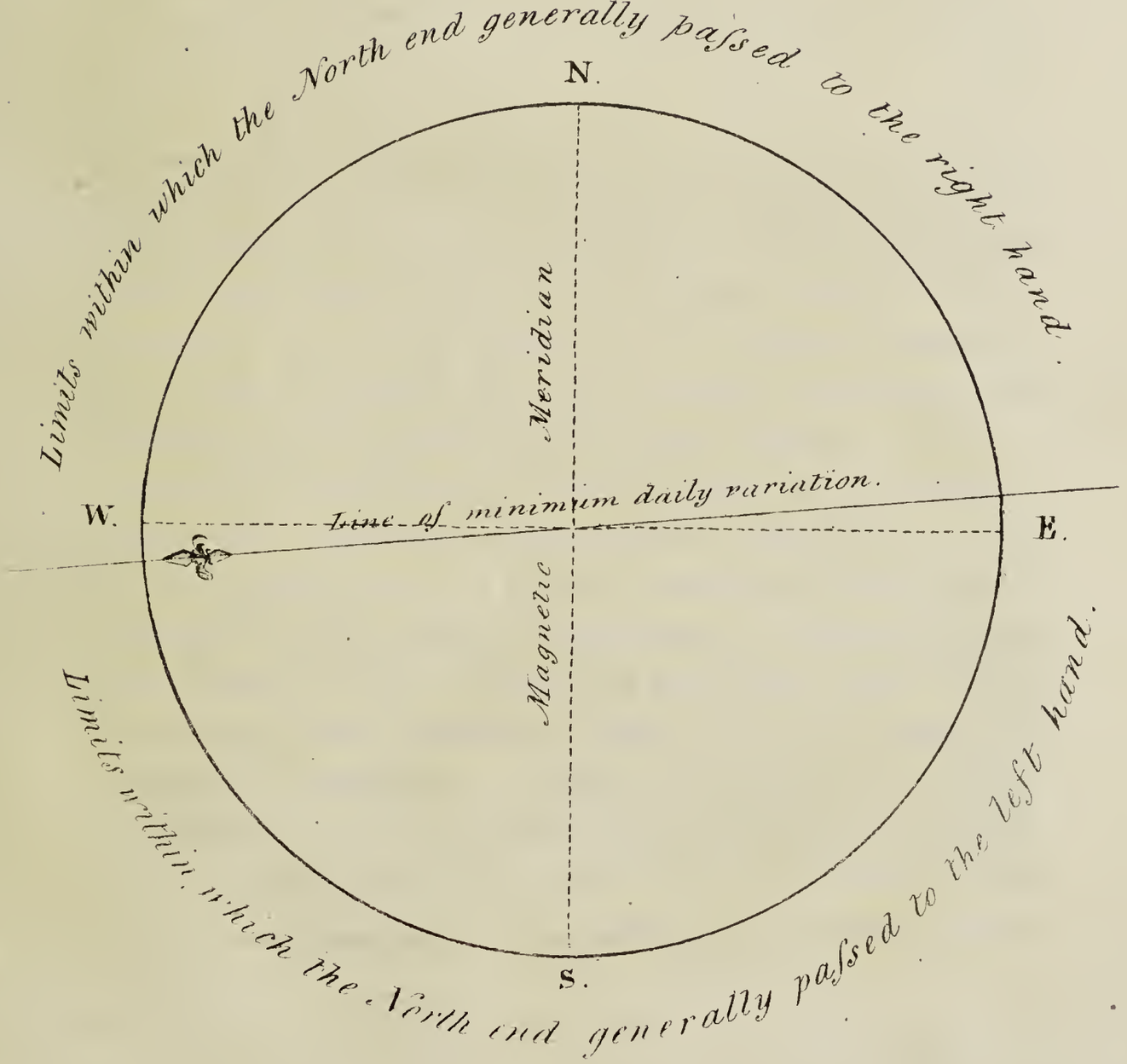
In the foregoing observations, when the north end of the needle was directed towards the east or west points of the compass, it will be seen, that the various deflections of the needle rendered it difficult to discover which way its north end had proceeded during the time of westerly daily variation.

This anomalous action of the needle exhibited itself so strongly on the 23d of February, that I was induced to compare the nature of some of its deflections, with simultaneous observations, on the times of vibration of a freely suspended horizontal needle; and as I found, in every instance of comparison, a decided relation between the changes of horizontal intensity, and these deflections, I began to watch the action of this needle more closely, at the times that fluctuations in the directive force of the horizontal needle, had hitherto been observed to take place; and from its indications, I frequently stated to the Gentlemen making the observations on horizontal intensity, what I considered would be the nature of the intervals they were about to obtain; which proving correct, no longer left any doubt on my mind, of the cause of these apparent irregularities. In order, however, to point out more satisfactorily the relation between the changes of horizontal intensity, and the various deflections of this needle, at other positions of its north end, I have annexed the observations on the times of performing 60 vibrations by a horizontal needle, taken during the same time; but this will not explain all the anomalies alluded to, without also stating, that the fluctuations which frequently took place in the intervals of 10 vibrations, were sometimes observed to compensate one another, so as, in the mean of sixty, to leave no

indications of such changes having taken place; and it is only on these occasions, that the expression for the magnetic intensity of the horizontal needle is at variance with the irregular motion of the neutralized needle.

On looking over the observations it will also be seen, that when the north end of the needle was directed to the southward, between N. 85° E. and S. 85° W. its motion during the time of westerly daily variation was generally towards the *left hand*, but when directed to the northward, between N. 85° E. and S. 85° W. its motion was then most commonly to the *right hand* (see the figure in Plate IV.); and that when held between N. 85° E. and north, a greater daily change obtained than at any of the other positions, amounting in one instance to 50 degrees; but when directed to S. 85° W. no daily variation, or at least a minimum, exhibited itself.

With respect to the effect produced on the needle when held between N. 85° E. and north, it appears, from observations on the times of vibrations of a horizontal needle, that an increased intensity generally took place about noon, at which time also, the maximum westerly daily variation generally happened; and as we have already seen, that the motion of the north end of the needle in this position, during the time of westerly daily variation, was to the *right hand*, or towards the magnetic meridian, the effect of an increased intensity would be to draw it still further in that direction, and therefore, produce the extraordinary amount noticed. But with the north end of the needle, held between S. 85° W. and north, where its motion is still to the *right hand* at the time of westerly daily variation, the effect of increased intensity then, would be to draw the north end of the needle to the


Limits within which the North end generally passed to the right hand.
N.
Meridian
W.
Line of minimum daily variation.
E.
Magnetic
S.
Limits within which the North end generally passed to the left hand.

left hand, or towards the magnetic meridian; from whence it is inferred, that these contrary effects balance each other at S. 85° W. and produce what has hitherto been termed the line of minimum daily variation. Nevertheless it is a singular coincidence, that the *true bearing* of this line at Port Bowen (viz. S. 38° 4′ E.) agrees nearly with Mr. BARLOW's determination at Woolwich. It would, however, be desirable to have other observations, at places differing much in magnetic position, before drawing any conclusions as to the probability of its dependance on some general cause; especially, since the needle after remaining absolutely stationary for three successive days at S. 85° W, commenced moving with its north end towards the *left hand*, or west point of the compass, at half-past three P. M. on the 27th of March; without any apparent cause whatever, and that it did not again become stationary during the rest of the observations at this point, which were continued until the 5th of April; in the course of which, as will be seen, its north end sometimes proceeded towards the *left*, and at others towards the *right hand*, during the time of westerly daily variation.

Whether this movement of the needle, on the 27th of March, took place in consequence of the changes of intensity in the opposing magnets (which were covered with snow), arising from the effects of temperature, or from the sudden variations of intensity of the horizontal needle which take place in short intervals of time, to which, I am most disposed to attribute it, is difficult to decide; it was not considered to be due to the effects of electricity, as there was no appearance of the Aurora * at the time, nor was

* The Aurora generally appeared about north by compass, extending in an arch

the existence of that phenomenon, in the atmosphere, detected by the electrometer.

Towards the end of May, however, I commenced another set of observations (at S. 85° W.), but the needle never became stationary throughout their continuance; its north end sometimes proceeding towards the north, at others towards the south, during the time of westerly daily variation, and that occasionally the needle was observed to vibrate in small arcs, as already noticed at its other azimuthal positions.

It will also be seen, on looking over the preceding observations, that the times of maximum westerly, and easterly daily variation, by this needle, differ on many occasions very considerably from those by the suspended needle: this difference it may be observed, arises from the circumstance of the observations on each needle not being made simultaneously, as well as from the minuteness of some of the phenomena escaping observation by the suspended needle; but which were elicited by this needle, proportionally to its reduced directive force. Besides these observations on the daily changes of the horizontal needle, I also attempted a similar set on the dipping needle, but the difficulty of adjusting the magnets was such, as to prevent me from obtaining any satisfactory results.

Port Bowen, July 1st, 1825.

from about N. E. to N.W. at an elevation of from 10 to 20 degrees, with streamers sometimes shooting towards the zenith. At times when it was brightest, although not very brilliant during any part of the winter, I have frequently watched this needle, without ever being able to detect a change, that could be ascribed to its influence.

VII. *A comparison of the diurnal changes of intensity in the dipping and horizontal needles, at Port Bowen.* *By* LIEUTENANT HENRY FOSTER, *R. N. F. R. S. Communicated February* 25, 1826.

THE following comparative observations on the intensity of the dipping and horizontal needles, were made with a particular object in view, which will be proper to explain before giving the details.

It was found by observation, that the intensity of the horizontal needle was hourly varying: this appeared by the results already given to this Society in a former paper: but it was doubtful, whether this variation of horizontal intensity of a needle, proceeded from an actual variation in the intensity of the terrestrial magnetism, or from a variation in the amount of its direction, as indicated by the dip itself.

The power of the horizontal needle varying as the cosine of the dip, a change to the amount of a few minutes in the dip, at places where it is very great, would be sufficient to explain all the variations of intensity observed in the horizontal needle, without supposing any change to have taken place in the intensity of the terrestrial magnetic force.

The variation in dip, however, if it did occur, was too small to be detected by direct observation; and I failed also, to render it sensible by the application of magnets, as stated in a former communication.

My object therefore in making the experiments contained

in the following Table, was to ascertain, by several series of vibrations made with the same needle, mounted alternately as a dipping needle, and as a horizontal one, whether or no a corresponding variation of intensity would manifest itself in these two positions respectively; as ought to be the case, if the diurnal changes of intensity in the horizontal needle proceeded from a general change of intensity in the terrestrial magnetic power. But on the other hand, if the force indicated by the dipping needle should be found to remain constant, then it would be equally clear, that the variations of intensity in the horizontal needle proceeded from an actual change of dip only.

As this question is of considerable importance in the theory of terrestrial magnetism, I regret that I had not an opportunity of making a more extended series of experiments of this kind; but, as far as they go, they certainly appear to indicate, that the alterations of intensity in the horizontal needle, are due rather to a daily change in the amount of the dip, than to any variation in the general intensity of the earth's magnetic force; although some change in this also is observable by the vibrations of the dipping needle This explanation of the cause of the change of horizontal intensity, it may be remarked, is consistent with the observations made in Europe, which likewise show an alteration of intensity in the horizontal needle during the day, but in a much less degree than at Port Bowen. Now, if the variation in question really proceed from a change of dip, to the amount of 3, 4, or 5 minutes of a degree, the change of intensity in the horizontal needle will be less and less obvious, as the dip decreases; but if it proceed from a change in the actual intensity of the earth's

magnetism, it ought to be constant in all parts of the world, which is contrary to observation.

In making these experiments, a dipping apparatus by DOLLOND, belonging to the Board of Longitude, was used. This instrument had a needle $11\frac{1}{2}$ inches in length, of an oblong shape, and rounded at its extremities; it was placed in the magnetic meridian, on a pedestal built of stones, and thus afforded the means for ascertaining the variations of intensity in the earth's magnetism, as indicated by the vibrations of the dipping needle. But as I had not a suitable apparatus for ascertaining the variations in horizontal intensity with the same needle; a cubical box 12 inches high was prepared, for which I was indebted to the kindness of Captain HOPPNER. This box had glass ends, to admit of the vibrations of the needle being observed, and contained at the bottom a horizontal circle, divided to every 5 degrees, for the purpose of measuring the arc of vibration; it was likewise fitted with a contrivance, by which the needle could be made to vibrate in any arc at pleasure, and the top was so constructed as to allow the suspension of the needle, to be placed directly over the centre of the circle. The suspension consisted of a few fibres of floss silk, attached to one of the extremities of the axis of the needle, just sufficient to sustain its weight, and several inches in length, to lessen the effects of torsion. This box was also mounted on a pedestal, similar to the one on which the dipping apparatus stood, and both were protected from the weather by being placed in a house built of snow. For observing the horizontal vibrations of this needle, a small telescope, having a vertical wire fixed in the focus of the eye-piece, was placed on a stand firmly frozen to the

ground, at the distance of about eight feet from the middle of the box, in the direction of the magnetic meridian: when the needle was at rest in its natural direction, a fine thread of light reflected from its end, was bisected by the vertical wire in the telescope; the telescope having a lateral sliding motion for the purpose of accomplishing this adjustment.

In making a set of these observations, the following mode was pursued: the needle being suspended horizontally, the adjustment of the telescope above described was first completed, after which, the needle was made to vibrate at the commencement, in an arc of 60 degrees, by the contrivance already alluded to; the time at which the reflected thread of light passed the wire in the telescope, was noted by means of a chronometer, and also at every tenth vibration following, until one hundred were completed: the needle was then removed from the box, and placed on its axis in the dipping apparatus; the time of its performing one hundred vibrations (commencing as before in an arc of 60 degrees) was in like manner noted; the passage of the central point in this case being determined by means of a lens, fixed over that part of the vertical circle to which the needle pointed, when freely supported on its axis and at rest. In this way all the results in the following Table have been obtained; it may not, however, be unimportant to state, that although the needle, in each of its different positions, always vibrated in the same arc at the commencement, viz. 60 degrees; yet the terminal arc, in either position, generally varied.

The Table is divided into two parts; the first contains the observations on the times of vibration of the needle in its horizontal position; and the second, those on it when used as

a dipping needle. In the first column of each part, is inserted the day of the month; in the second, the hour and minute at which the observations were commenced; the third column of each part, contains the mean time in seconds taken by the needle in its different positions, to perform one hundred vibrations; and in the fourth, is inserted the temperature of the needle at the time of observation.

1st Part, Horizontal Needle.				2d Part, Dipping Needle.			
Date.	Time of Commencement.	Mean time in seconds, of performing 100 vibrations.	Temp. Fah^{t}.	Date.	Time of Commencement.	Mean time in seconds, of performing 100 vibrations.	Temp. Fah^{t}.
1825.	h. m.	s.	°	1825.	h. m.	s.	°
Feb. 12th	A.M. 6 35	2128,6	— 17	Feb. 12th	A.M. 11 58	405,4	— 17½
	10 54	2127,6	— 17		P.M. 0 30	405,7	— 17½
	P.M. 1 32	2079,9	— 17	13th	P.M. 3 41	410,0	— 17½
13th	P.M. 1 42	2103,1	— 17	14th	A.M. 10 34	408,0	— 19½
	2 54	2152,5	— 17½		P.M. 0 12	406,5	— 20
14th	A.M. 11 21	2088,2	— 20		8 33	408,4	— 22
	P.M. 1 14	2067,7	— 20		10 00	409,0	— 21½
	9 00	2086,0	— 22		11 12	408,7	— 21½
15th	A.M. 0 41	2107,0	— 22	15th	A.M. 1 34	411,1	— 22
	10 48	2115,5	— 21		10 32	410,0	— 21
	P.M. 8 44	2064,2	— 23		11 35	409,6	— 21
	10 29	2071,0	— 23		P.M. 8 9	409,2	— 23
16th	A.M. 11 4	2077,4	— 27		9 43	408,7	— 23
17th	A.M. 10 18	2071,0	— 22		11 15	409,2	— 22
	11 12	2058,2	— 21	16th	A.M. 10 38	409,9	— 28
	P.M. 0 29	2079,5	— 20		11 46	409,1	— 27
19th	A.M. 10 18	2092,2	— 22½	17th	A.M. 9 42	409,0	— 22
					11 54	408,5	— 20
					P.M. 1 10	409,0	— 20½
				19th	A.M. 10 00	408,5	— 23
					10 58	408,1	— 22
* Mean		2092,33	— 20½	* Mean		408,65	— 21½

* The dip of the needle resulting from these elements is 87° 48′,8 N.

The above results show, that the mean of all the observed times which the horizontal needle required to make one hundred vibrations was 2092,33 seconds, but that differences appear in these times amounting to 94,3 seconds, or $\frac{1}{22}$ part of the interval; whereas in the dipping needle, in which the mean of the times required to perform one hundred vibrations was 408,65 seconds, the greatest difference is only 5,7 seconds, or $\frac{1}{72}$ part of the interval, which is a much less proportional change than the former. As an additional confirmation, however, that the intensity of the earth's magnetism is not subject to much variation, I have given in the following Table the results of observations I made on it at the same place in November, 1824, January and June, 1825. These exhibit the times in which the needle completed one hundred vibrations in the magnetic meridian, deduced from the mean of the times of its performing four hundred vibrations, with the face of the instrument on each side of the vertical, and the needle reversed on its axis in the two positions.

Date.	Middle Time of Observation.	Mean time in seconds of performing 100 vibrations.	Temperature. Fah^{t}.
	h. m.	s.	o
November 8th	A. M. 10 20	404,94	— 13½
January 10th	A. M. 11 45	404,69	— 22
June 27th	A. M. 9 30	406,50	+ 47

These results also show, taking into consideration the different temperatures under which they have been obtained, that little or no change in the intensity took place, notwithstanding the observations were made at different hours of the day, as well as at different parts of the year.

Therefore, as has been stated, the change of intensity in the horizontal needle is due, principally, to a daily variation in the amount of the dip; not to a real change of intensity in the terrestrial magnetic force. This at least appears to be a legitimate deduction from the preceding observations; from which circumstance, and that of the daily variation in the direction of the horizontal needle, we are naturally led to the conception of a small variation in position of the magnetic axis, corresponding to a revolution of the polar point round its mean position as a centre, produced by the action of the sun, on the magnetism of the parts of the earth, successively exposed to its influence. And, moreover, it seems by no means improbable, that the annual variation of the position of the magnetic pole may ultimately be traced to the same universal cause.

I have not attempted to enter into any minute calculations on this subject, but I believe it will be found, that if the radius of the circle, described by the pole of the general magnetic axis of the earth during the day, be supposed to subtend at the centre an angle of 2 or $2\frac{1}{2}$ minutes, it will reconcile, to a considerable degree of precision, nearly all the observations on the daily variation of the direction, and daily change of intensity of the horizontal needle, made both in Europe and within the Arctic Circle. If, also, we suppose the magnetic north pole, during the passage of the sun over its meridian, when lying between the pole of the world and the sun, to advance more to the westward, or in a direction contrary to the rotation of the earth on its axis, than it returns to the eastward, or in the direction of rotation of the earth during the sun's passage over the opposite meridian, when the pole

of the world lies between the magnetic pole and the sun, then it follows, that in some certain number of years the magnetic north pole will perform a revolution from east to west round the pole of the earth, and produce an annual change in the variation of the compass in that direction, which is known to obtain. That this may be the case, is rendered probable, by considering that the sun at present approaches nearer to the magnetic north pole in its southern, than in its northern passage over the meridian, by twice the north polar distance of the magnetic pole; and although the reverse takes place on the south pole, yet, as the sun is longer on the northern than on the southern side of the equator, there will be a preponderance of action to carry the north pole forward to the westward, and consequently the south pole to the eastward, as is supposed to be the case by many eminent philosophers in this country.

However, these observations will, of course, require to be repeated in other parts of the world, before this hypothesis can be considered as fully confirmed by experiment.

In this concluding communication relative to our recent northern magnetic experiments, I beg leave again to express my obligations to Mr. BARLOW and to Mr. CHRISTIE. To Mr. CHRISTIE, for his kindness in permitting the observations on the dip and magnetic intensity to be made in his garden at Woolwich, and for the valuable assistance he rendered me in the equipment of the magnetical instruments supplied to the Expedition. To Mr. BARLOW, I stand indebted in a manner which I find it difficult to describe; indeed it is no more than due to the scientific liberality of this Gentleman to state, that on many occasions, when I have shown him my experiments

on the different magnetical subjects wherein I have been engaged, he has kindly given such a direction to my thoughts, as materially to assist me in arriving at the conclusions I have drawn.

P.S. That the magnetic pole moves in an orbit round the pole of the earth, was first conceived, I believe, by Mr. DERHAM, as appears from the Appendix to Philosophical Essays, in three parts, by R. LOVETT, lay clerk of the cathedral church at Worcester, published in 1766, which was put into my hands by a friend, on mentioning to him the theoretical views advanced in this paper. This Appendix contains a brief theory of the north magnetic pole adopted by him from a passage in DERHAM's Physico-Theology, which I shall transcribe in Mr. DERHAM's own words, who, after stating the various discoveries of NORMAN, GELLIBRAND, and others, proceeds to say; "To these discoveries, I hope the reader "will excuse me if I add one of my own, which I deduced "some years ago, from some magnetical experiments and "observations I made; which discovery I also acquainted "our Royal Society with some time since, *viz.* that as the "common horizontal needle is continually varying towards "the east and west, so is the dipping needle varying up and "down, towards or fromwards the zenith, with the magne-"tick tendency describing indeed a circle round the pole of "the world, as I conceive, or some other point; so that if "we could procure a needle so nicely made, as to point ex-"actly according to its magnetick direction, it would in some

" certain number of years describe a circle of about 13*gr.*
" radius round the magnetick poles northerly and southerly.
" This I have for several years suspected, and have had some
" reason for it too; and three or four years ago, mentioning
" it at a meeting of our Royal Society, they were pleased to
" cause it to be entered in the Journals; but I have not yet
" been so happy to procure a tolerable good dipping needle,
" or other proper one to my mind, to bring the thing to
" sufficient test of experience; as in a short time I hope
" to do, having lately hit upon a contrivance that may do
" the thing."

Mr. LOVETT next proceeds to illustrate Mr. DERHAM's theory by appropriate diagrams, and then to compute the latitude of the magnetic pole from the best recorded observations at the time on the variation of the compass at two well known places. Having thus obtained 13° 51′ for the north polar distance of the magnetic pole, or radius of the orbit which it describes round the pole of the earth, he then fixes the year of no variation of the magnetic needle in London to be 1660, from the observations of Dr. HALLEY in 1672; and from a similar observation by Dr. BRADLEY in 1750, he deduces the longitude of the pole for that time, and by this interval of 90 years, he infers the progressive rate of the pole westerly to be in longitude 7° 7′ 12″ every ten years. With these data he has computed a table of variations of the compass for every ten years between 1660 and 1910, in which he has predicted, with near approximation to what has since been observed, considering the distance of time and want of correct knowledge of its quantity, not only the

amount of the variation, but the year in which the magnetic pole arrives at its maximum westerly position. He also states, that in $1912\frac{1}{2}$ the magnetic pole will again be on the meridian of London, and that it requires 505 years, 215 days, 8 hours, and 24 minutes, to make a complete revolution round the pole of the world.

VIII. *Account of the repetition of Mr.* CHRISTIE'S *experiments on the magnetic properties imparted to an iron plate by rotation, at Port Bowen, in May and June,* 1825. *By Lieutenant* HENRY FOSTER, *R. N. F. R. S.; together with Mr.* CHRISTIE'S *remarks thereon.*

PREVIOUS to our leaving England in 1824, Mr. CHRISTIE stated to me that he had some time ago discovered singular magnetic properties to be imparted to iron by simply making it revolve about an axis, and that these properties were exhibited in the different deviations which a plate of that metal would cause in a horizontal needle, according as it was made to revolve gently by the hand in one direction or the opposite: wishing me also to pursue these experiments as opportunites offered, in the high magnetic latitudes we were likely to visit in H. M. S. Hecla. The memorandum with which he furnished me on this subject, suggested that the plate should be placed in certain magnetic positions to the compass; for which purpose, unfortunately, I had no proper instrument. Through the kindness, however, of Captains PARRY and HOPPNER, I was enabled to employ the carpenter of the Fury in constructing a suitable apparatus; and I feel much satisfaction in acknowledging my obligations to them, for the ready assistance they afforded me on this, as well as on other occasions. The instrument, which answered the purpose extremely well, is briefly described as follows. Plate V. A B, fig. 1, is the stand of the instrument, C D E F

Fig. 1.

Fig. 2.

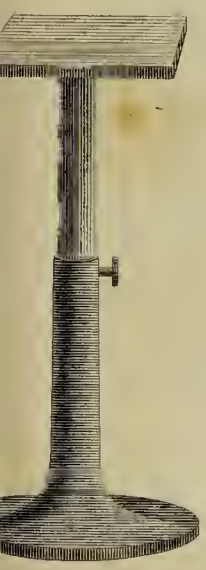


Fig. 3.

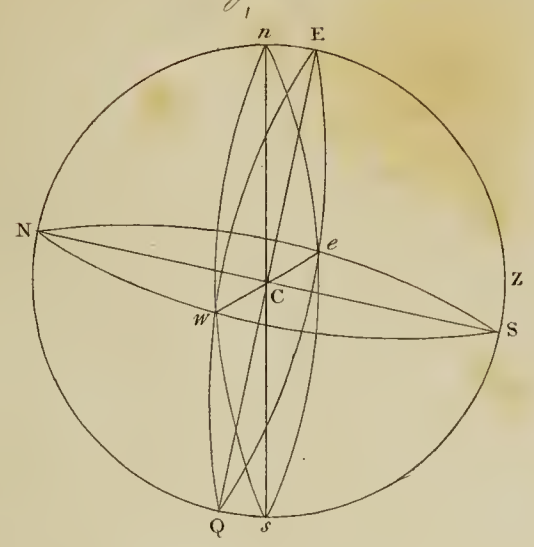


Fig. 4.

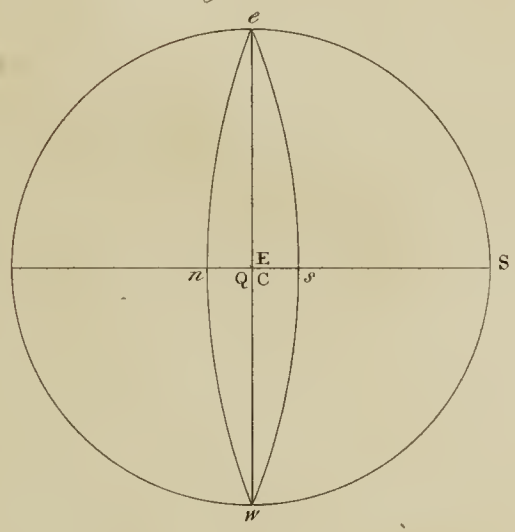
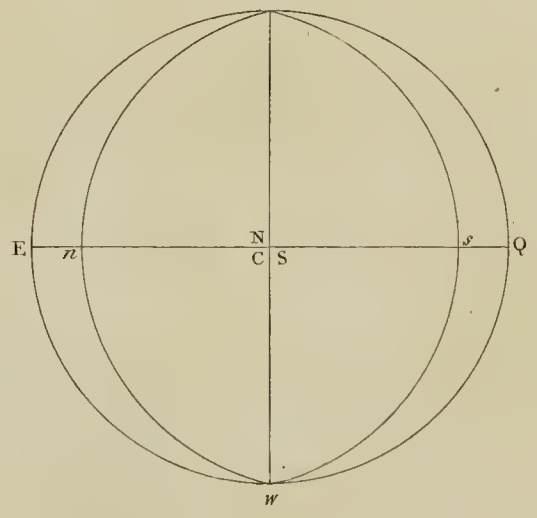


Fig. 5.



a wooden frame, across the upper part of which passes a copper bolt, G H, with clamping screws at *s s*. This bolt was flattened and bent down in the middle, as shown at K, where the compass was placed. L M N O is a copper frame, with two pins, T and V, inserted into it, to carry the circular iron plate, as shown also in the figure. It is obvious, that with this instrument I was enabled to place the iron plate in any latitude by means of the graduated circle *a a* and plummet *p*, while by turning the frame C D E F in azimuth, it might, in like manner, be placed in any longitude: in all these cases the plane of the plate being a tangent to the sphere. When it was required to place the plate, with its edge pointing to the centre of the needle, or its plane in the plane of the secondary to the equator and meridian, I then employed the small stand shown in fig. 2, which might be elevated to any height to bring the compass, which was placed on its top, to the required position. It was also employed when the plane of the plate coincided with that of the equator.

In order to understand the particular positions in question, it will be best to refer to figures 3, 4 and 5. Fig. 3, represents the sphere circumscribing the needle viewed on the plane of the meridian; 4, on the plane of the secondary; and 5, on the plane of the equator. In fig. 3, C is the centre of the compass, S N the magnetic axis or line of the dip, E *w* Q and *e* the equator, S E N Q the meridian, S *e* N *w* the secondary, *n w s e* the horizon, *n s* the horizontal magnetic meridian or axis of the horizontal needle, and *e c w* the east and west line. The points at which Mr. CHRISTIE wished observations to be made, were at E, S, Q, N, *e* and *w*, with the plane

of the plate a tangent to the sphere at each ; that is, at E and Q the plate would revolve about the line E Q, and at S and N about the line S N, &c. But with the plane of the plate in the plane of the secondary, he was most desirous that observations should be made ; and at the points *s*, *w*, N and *e*, fig. 4. I also made a set of observations at the points *e*, *w*, E, Q, fig. 5, the plane of the plate being in the plane of the equator.

In consequence of the extent of the changes in the daily variation, I was under the necessity of making the observations in a different manner from that adopted by Mr. CHRISTIE; they were in general made as follows.

The circular iron plate before mentioned, being divided into six equal parts, marked 0, 60, 120, 180, 240, 300, and the instrument above described so adjusted, that when the plate was placed on the copper pin T or V, its centre would occupy the position required ; the plate was then placed on the pin, with the point 0, coinciding with the fixed mark or index, and the direction of the north end of the needle noted ; after which the plate was made to revolve three times for instance, gently by the hand, its upper edge moving from east to west, and 0, being again brought to coincide with the index, the direction of the north end of the needle was again noted ; and the same was done, after making the plate revolve in like manner from west to east: the difference between the first and second reading, gave the deviation due to rotation from east to west ; and the difference between the first and third, that due to rotation from west to east. The plate was then moved to a distance, in order that an allowance, if necessary, might be made for the change in the direction of the needle caused by the daily variation. After this, the plate

was again fixed in its proper position, with its point 60 coinciding with the index, and the deviation caused by rotation obtained in the same way, and in like manner for the rest of the points 120, 180, 240, 300, 0, in their order, and likewise in the order of succession 300, 240, 180, 120, 60, 0.

The various effects due to the rotation of the plate, when placed in the different magnetic positions above specified, are noted in the tabulated experiments at each: it may nevertheless be proper here to state the nature of these deviations, in the different adjustments of the plate to the compass; as for instance, in the experiments with its plane in the plane of the secondary, placed at S and N, fig. 4, 16,4 inches from the centre of the needle, the deviations were invariably to the east; when its upper edge was made to revolve from west to east, and to the west in the opposite rotation: at the points *e* and *w* effects just the contrary were produced, *viz.* that while the upper edge of the plate revolved from west to east, the deflections were to the west, and in the opposite rotation to the east; from which circumstance it was inferred, that there must be an intermediate latitude where no deviations of the needle would be produced by rotation, and this by experiment was ascertained to be latitude $52°\frac{1}{3}$ North and south, as stated in the observations. The effects of rotation of the plate on the needle when placed with its plane a tangent to the sphere, at the points E and Q, fig. 3, were considerable, and always to the west, the upper edge revolving from east to west; but at the other positions N S *e* and *w*, no effect due to rotation was observable. The maximum effect of rotation (amounting to 108° in one instance) was produced with the plate in lat. $52°\frac{1}{3}$ N, long. 270°, thirteen inches from the

centre of the needle, and also in lat. $52^{\circ}\frac{1}{3}$ S, long. 90°. These unusual quantities are doubtless attributable to a circumstance I had previously noticed in the voyage of H. M. S. Griper to Spitsbergen, where it was found, that with the ship's head to the southward, the iron in the vessel neutralized the needle, or nearly so, and thereby left it free to obey any new force impressed upon it; and so in these cases. In both the positions specified, it will be seen that the needle was nearly neutralized by the plate, and therefore the effect of rotation was more strongly exhibited; the character of these deflections were generally to the east of zero, or reading previous to rotation: but when the action of the plate co-operates with that of the earth, the contrary to the above effect of rotation of course takes place. In this case the horizontal intensity of the needle being increased, the effect produced by rotation is diminished, as will be seen when the plate was placed in lat. $52^{\circ}\frac{1}{3}$ N, long. 90°, and in lat. $52^{\circ}\frac{1}{3}$ S, long. 270°: in both these positions the upper edge being made to revolve from east to west, the needle was deflected to the west. The centre of the plate placed in lat. $52^{\circ}\frac{1}{3}$ N, long. 0°, and in lat. $52^{\circ}\frac{1}{3}$ S, long. 180°, the upper edge revolving from south to north, the deviations were to the west, and of greater amount than those to the east, caused by the rotation of the plate in the opposite direction. Effects, however, precisely contrary to these last mentioned were produced by the revolutions of the plate, when fixed with its centre in lat. $52^{\circ}\frac{1}{3}$ S, long. 0°, and in lat. $52^{\circ}\frac{1}{3}$ N, long. 180°. When the plate was adjusted with its plane in that of the equator, and its centre in the various magnetic positions specified in the experiments, very trifling deviations due to rotation were

produced, and those probably arose from errors in the adjustments themselves.

The following effects were also noticed in the course of these experiments, *viz.*

(1st.) In the different adjustments of the plate, it was found in general that the amount of the deviation from zero, due to rotation in the same direction, when the several points on the plate coincided with the fixed mark, was greater or less, according as the plate had been adjusted on the pin in the successive observations, with the several points coinciding with the fixed mark in the order 0, 60, 120, 180, 240, 300, or in the order of succession 300, 240, 180, 120, 60, 0; although the whole amount of deviation due to rotation in opposite directions, was not sensibly affected by this circumstance. This effect is fully pointed out in Table I. and its probable cause suggested.

(2nd.) *One slow* revolution of the plate produced as much deviation as *three or more turns; quick* revolutions were always attended with comparative trifling deflections of the needle. The plate retained the magnetic properties imparted to it by rotation, while remaining on the axis, round which it was made to revolve;* but on its being placed horizontally on the ground, (which in this place was nearly in the plane of the magnetic equator), the effect was destroyed in the course of 10 or 15 minutes; implying that *time* is requisite for the complete developement of magnetism in the plate, as well as for the displacement of it, after it has been produced.

* This is inferred from the observations of $1\frac{3}{4}$ hour only, during which time the direction of the daily variation needle was noted, and compared with that under the influence of the plate.

(3rd.) Oscillating the plate in different arcs, with its plane a tangent to the magnetic sphere, after the manner of the balance wheel of a watch, caused considerable deviations of the needle. In this experiment also, *quick* vibrations produced the least effect.

In Table I. the observations are given at length, in order to exhibit the peculiar effect, already noticed, arising from the order of succession in which the points 0, 60, 120, &c. were in the first instance brought to coincide with the fixed mark. The second column shows this order, and the third column, the zero or reading of the north end of the needle when the plate was placed on the pin previous to rotation.

I.

Table of the changes in the zero, or reading of the north end of the needle, and of the deviations due to the rotation of a circular iron plate (18 inches in diameter), its plane being in the plane of the secondary to the equator and meridian, and its centre in latitude 0°, longitude 180°, at the distance of 16,5 inches from the centre of the needle.

Temperature. Fahrenheit.	Points on plate brought to coincide with fixed mark on pin, before and after rotation.	Zero, or reading of north end of needle before rotation.	Readings of north end of needle after plate had revolved, its upper edge,		Deviation of north end of needle due to rotation of plate, its upper edge.		Deviation due to rotation in opposite directions.	Remarks.
			From East to West.	From West to East.	From East to West.	From West to East.		
°	°	° ′	° ′	° ′	° ′	° ′	° ′	
+14	60	1 20W	10 20 E	3 00W	11 40 E	1 40W	13 20	
	120	12 40 E	20 20 E	6 40 E	7 40 E	6 00W	13 40	
	180	1 00 E	12 10 E	0 30W	11 10 E	1 30W	12 40	
	240	3 30W	1 45 E	11 55W	5 15 E	8 25W	13 40	
	300	13 15W	3 15W	15 35W	10 00 E	2 20W	12 20	
	0	0 50W	4 00 E	9 30W	4 50 E	8 40W	13 30	3 gentle turns.
+13	60	3 10W	10 00 E	3 50W	13 10 E	0 40W	13 50	
	120	12 20 E	21 30 E	7 40 E	9 10 E	4 40W	13 50	
	180	4 30 E	15 00 E	1 30 E	10 30 E	3 00W	13 30	
	240	5 10W	1 20 E	11 35W	6 30 E	6 25W	12 55	
	300	17 40W	5 20W	19 20W	12 20 E	1 40W	14 00	
+13	0	2 10W	3 50 E	10 00W	6 00 E	7 50W	13 50	
+13,3	Means	1 23W	7 38$\frac{4}{12}$ E	5 47$\frac{1}{12}$W	9 1$\frac{3}{12}$ E	4 24$\frac{2}{12}$W	13 25$\frac{5}{12}$	
	300	6 40W	5 00W	17 45W	1 40 E	11 5W	12 45	
	240	2 50 E	3 40 E	9 30W	0 50 E	12 20W	13 10	
	180	13 30 E	15 20 E	1 30 E	1 50 E	12 00W	13 50	
	120	14 55 E	19 35 E	5 25 E	4 40 E	9 30W	14 10	
	60	9 45 E	9 45 E	3 20W	0 00	13 5W	13 5	
+14	0	3 10W	3 50 E	9 10W	7 00 E	6 0W	13 0	3 gentle turns.
	300	4 40W	3 40W	16 40W	1 00 E	12 0W	13 0	
	240	3 30 E	3 15 E	11 15W	0 15W	14 45W	14 30	
	180	10 50 E	13 00 E	0 20 E	2 10 E	10 30W	12 40	
	120	13 15 E	18 15 E	4 15 E	5 00 E	9 00W	14 00	
	60	2 00 E	9 00 E	3 10W	7 00 E	5 10W	12 10	
+14	0	5 45W	4 50 E	7 20W	10 35 E	1 35W	12 10	
+14	Means	4 11$\frac{8}{12}$E	7 39$\frac{2}{12}$ E	5 33$\frac{4}{12}$W	3 27$\frac{6}{12}$ E	9 45W	13 12$\frac{6}{12}$	

On looking over the several columns of the preceding Table, it will be seen that the zeros for the same point changed according as the points on the plate were made to coincide with the fixed mark or index in the order of 0, 60, 120, 180, &c. or in the order of 0, 300, 240, 180, &c. and also, that when they were applied in the order of 0, 60, 120, 180, &c. the easterly deviation produced by the rotation of the plate from east to west, was greater than the westerly deviation caused by its rotation from west to east; and that precisely the reverse took place when the points of the plate were applied in the order of 300, 240, 180, &c. From the manner in which the deviations due to the rotation of the plate were obtained, for each order of succession of the points, marked on its surface; it is obvious that the plate made two complete revolutions during the series; the first in the direction from west to east, in consequence of the manner in which the points were numbered on the plate, and the second from east to west; to which circumstance is attributed the change that is observed in the zeros, or readings before rotation, as well as, that the amount of the deviations, due to rotation from east to west, and from west to east, change in their respective columns.

Observations similar to those in Table I. were made when the centre of the plate was in the several situations indicated in Tables II. and IV.; but as it was considered that giving them in detail would unnecessarily extend this communication, the mean results have been collected in these Tables, and the observations at length deposited with the Royal Society, in order that they may be consulted should any of the results appear of sufficient interest to require minute investigation at a future time.

II.

Table of the mean deviations due to the rotation of the plate, its plane being in the secondary to the equator and meridian, and its centre at the distance of 16,5 inches from the centre of the needle.

Position of the plate's centre.		Zero, or mean readings of north end of needle before rotation.	Mean of readings of north end of needle after plate had revolved, its upper edge from		Mean deviation of north end of needle due to rotation of plate, its upper edge from		Mean deviation due to rotation in opposite direction.	Temperature. Fahrenheit.	Remarks.
Lat.	Long.		East to West.	West to East.	East to West.	West to East.			
°	°	° ′	° ′	° ′	° ′	° ′	° ′	°	
0	0	0 35W	10 26 E	4 42W	11 1 E	4 7W	+15 8	+16½	1 turn in 1 min.
0	180	1 24 E	7 39 E	5 40W	6 15 E	7 4W	+13 19	+13½	3 turns, slow.
52⅓ S	0	69 6W	68 51W	68 57W	0 15 E	0 9 E	+ 0 6	+12	1 turn in 1 min.
52⅓ S	180	69 7 E	69 12 E	69 12 E	0 5 E	0 5 E	0 0	+12	1 turn in 1 min.
52⅓ N	0	71 4 E	70 59 E	70 47 E	0 5W	0 17W	+ 0 12	+18	2 turns in 2 min.
52⅓ N	180	71 15W	71 6W	71 8W	0 9 E	0 7 E	+ 0 2	+18	1 turn in 1 min.
90 S		1 00 E	0 55W	4 37 E	1 55W	3 37 E	− 5 32	+17	3 turns, slow.
90 N		0 22 E	3 19W	4 6 E	3 41W	3 44 E	− 7 25	+12	1 turn in 1 min.

It appears from these observations, that in latitude $52° \frac{1}{3}$ North or South, the deviation due to rotation nearly vanished; but I do not profess to have got the latitude of this point to any great degree of accuracy, the nature of the construction of the instrument used, not admitting of the measurements from the centre of the plate, to that of the needle, being taken sufficiently near for that purpose; but I think it is obtained within the limits of a degree.

III.

Table of the deviations due to rotation of the plate, its plane being in the plane of the equator, and its centre 15 inches from that of the needle.

Position of the centre of plate	Lat. = 0° Long. = 0°		Lat. = 0° Long. = 90°		Lat. = 0° Long. = 180°		Lat. = 0° Long. = 270°		Temperature. Fahrenheit.	Remarks.
Direction of rotation of upper edge of plate	From East to West.	From West to East.	From East to West.	From West to East.	From East to West.	From West to East.	From East to West.	From West to East.		
Points on plate coinciding with fixed mark.										
0	12 15 E	12 00 E	4 0 E	4 20 E	6 20 E	6 00 E	7 0 E	7 00 E	+18	3 gentle turns
60	14 00 E	13 45 E	6 10W	5 40W	9 30 E	8 40 E	3 30 E	3 40 E		
120	17 20 E	17 10 E	4 30W	4 00W	17 00 E	16 40 E	4 20 E	4 20 E	.....	
180	13 30 E	13 20 E	3 00W	3 00W	8 00 E	7 40 E	1 40 E	1 40 E		
240	11 40 E	11 45 E	0 30 E	0 30 E	6 20 E	6 00 E	7 20 E	7 20 E		
300	3 40 E	3 40 E	3 10 E	3 10 E	2 40 E	2 20 E	5 55 E	5 50 E	+18½	
Means .	12 4⅙ E	11 56⅔ E	2 0W	1 20W	8 18⅓ E	7 53⅓ E	4 57½ E	4 58⅓ E	+18¼	
Deviations due to rotation in opposite directions	+ 0° 7½′		— 0° 40′		+ 0° 25′		— 0° 0⅚′			

The amount of deviations caused by rotation in this adjustment of the plate to the compass, being so small and irregular, they may be considered as due to the circumstance of the plate not accurately occupying the place assigned to it, since the slight inequalities of the surface of the plate did not admit of the pivot of the needle being absolutely placed in its plane produced.

The character + is prefixed to those deviations, the direction of which, were towards that point, from whence the upper edge of the plate was first turned, and — when the contrary.

IV.

Table of the mean deviations due to the rotation of the plate, its plane being a tangent to the sphere, and its centre at the distance of 13 inches from the centre of the needle.

Position of the plate's centre.		Zero, or mean reading of north end of needle before rotation.	Mean of readings of north end of needle after plate had revolved, its upper edge.		Mean deviation of north end of needle due to rotation of plate, its upper edge		Mean deviation due to rotation in opposite directions.	Temperature. Fahrenheit.	Remarks.
Lat.	Long.		From East to West.	From West to East.	From East to West.	From West to East.			
°	°	° ′	° ′	° ′	° ′	° ′	° ′	°	
0	90	0 28 E	3 12W	4 2 E	3 40W	3 34 E	+ 7 14	+ 7½	3 turns, slow.
0	270	1 20 E	3 40W	3 14 E	5 00W	1 54 E	— 6 54	+ 9½	3 turns.
52⅓ S	90	28 52W	27 52W	3 32 E	1 00 E	32 24 E	+31 24	+34	1 turn in 1 min.
52⅓ S	270	1 05 E	0 10W	1 48 E	1 15W	0 43 E	— 1 58	+32	1 turn in 1 min.
90 S		1 13W	1 20W	0 57W	0 7W	0 16 E	— 0 23	+10	3 turns.
52⅓ N	90	2 11 E	1 8 E	3 3 E	1 3W	0 52 E	+ 1 55	+31½	1 turn in 1 min.
52⅓ N	270	7 2W	15 43W	18 35 E	8 41W	25 37 E	—34 18	+32	1 turn in 1 min.
90 N		1 52 E	1 40 E	1 42 E	0 12W	0 10W	+ 0 2	+10	3 turns.
			From Nor. to South.	From Souh to North.	From Nor. to South.	From Souh to North.			
0	0	1 8 E	1 8 E	1 8 E	0 00	0 00	0 00	+ 9½	3 turns, slow.
0	180	1 27 E	1 33 E	1 30 E	0 6 E	0 3 E	— 0 3	+10	3 turns.
52⅓ S	0	42 4W	41 42W	40 00W	0 22 E	2 4 E	— 1 42	+35	1 turn in 1 min.
52⅓ S	180	45 35 E	44 31 E	42 35 E	1 4W	3 00W	— 1 56	+32	1 turn in 1 min.
52⅓ N	0	44 36 E	44 12 E	42 19 E	0 24W	2 17W	+ 1 53	+33	1 turn in 1 min.
52⅓ N	180	43 8W	41 53W	40 21W	1 15 E	2 47 E	+ 1 32	+36	1 turn in 1 min.

Some observations similar to these were made with the centre of the plate at the distance of 16 inches from that of the needle, in which the peculiar effects, already pointed out in this experiment, were exhibited with greater regularity, though to a less extent; but as the whole series was not completed, they have been omitted here, and are deposited along with other observations on the effects produced on the needle by oscillating the plate in different arcs.

HENRY FOSTER.

Port Bowen, July 12, 1825.

Mr. CHRISTIE's *Remarks on the repetition of his experiments by Lieut.* FOSTER, *at Port Bowen, in* 1825.

HAVING a considerable time previous to the sailing of the late North-Western Expedition, in 1824, discovered that peculiar magnetic effects were produced in iron by rotation, I was desirous of having some of the experiments which I had made, repeated under the very interesting circumstances, as connected with magnetic phenomena, in which that expedition was likely to be placed. Mr. FOSTER readily offered to do this; and I feel happy in having this opportunity of acknowledging my obligations to him for the zealous and careful manner in which he performed the task which he had so kindly undertaken.

The peculiar effects produced on the magnetic needle by the rotation of an iron plate, of which I have given an account in a Paper published in the last volume of the Transactions, are in this latitude (magnetic) rather minute; but I expected that in the high magnetic latitudes likely to be visited by the expedition, these effects being increased in the inverse ratio of the cosine of the dip, they would become very conspicuous; and that some phenomena which here, from their extreme minuteness, would escape observation, in those latitudes would be easily observable. The result has fully answered the expectations which I formed: at Port Bowen, where the dip is more than 88°, the phenomena were exhibited on so striking a scale, and the interest which they excited was such, that Mr. FOSTER devoted much more time

to their investigation than I could have at all contemplated, knowing how fully his time must be otherwise occupied. To those who have previously read my Paper on this subject in the Transactions, the general accordance of the results in the foregoing tables, and those which I obtained, must be quite manifest; as however they exhibit some differences, I shall here briefly point out the agreement between the original experiments and this repetition of them, and likewise those discordances, and at the same time indicate what I consider to be the cause of some of these apparent discrepances.

In all the observations which I made, the deviations of the needle due to the rotation of the plate, depended both in extent and character, not upon the situation of the plate with respect to the axis and equator of the horizontal needle itself, but upon its situation with reference to the axis and equator of an imaginary dipping needle having its centre coinciding with that of the horizontal needle; and this appears most clearly to have been the case at Port Bowen.

In every instance the direction of the deviation due to rotation was the same at Port Bowen as I had found it here, the relative positions of the plate and needle, and the direction of rotation being the same in the two cases.

When the plane of the plate was in the secondary to the equator and meridian, I had found that the mean deviation due to rotation in latitude 0 was + 1° 36′ and in latitude 90, — 0° 45′: at Port Bowen the corresponding deviations were + 14° 14′ and — 6° 28′, which are as nearly in the same ratio as we could expect, considering the irregularities which take place in the individual observations in the latter case.

The situation of the point where the deviation due to rotation vanishes, is somewhat different in the two cases; Mr. FOSTER'S observations giving its latitude $52°\frac{1}{3}$ and mine $54°\frac{3}{4}$. The method by which Mr. FOSTER was under the necessity of determining the situation of the plate's centre, as referred to that of the needle, did not, as he states, admit of considerable accuracy, but the errors to which it was liable would scarcely account for the difference in the two cases. I cannot attribute this difference to errors in estimating the situation of the plate's centre in my own observations, since this was determined on the graduated limb of the instrument by the index on the arm on which the plate was carried, and the effect of any error of centering in the compass would be counteracted by the opposite readings. As, however, the situation of this point is by no means an indifferent question in the theoretical investigation of the phenomena dependant upon rotation, I shall, when I have sufficient leisure, repeat my observations.

When the plane of the plate was a tangent to the sphere, and its centre in the meridian, I had found that the deviation due to rotation vanished when the plate's centre was at the pole, and was a maximum when in the equator: according to Mr. FOSTER'S observations it likewise vanishes at the pole, but the maximum takes place at a point intermediate to the equator and south pole in longitude 90°, and to the equator and north pole in longitude 270°. The situation of the point of maximum deviation at Port Bowen, I have no doubt arose, as I pointed out to Mr. FOSTER, from this circumstance, that when the centre of the plate is in south latitude in longitude 90°, or in north latitude in longitude

270°, the directive intensity of the horizontal needle is diminished by the attraction of the iron plate; and although this diminution would produce effects scarcely observable here, where the intensity of the horizontal needle is great, and the deviation due to rotation very small, yet when the case is reversed, as in the Port Bowen observations, the effect will be so sensible, that the increase in deviation from this cause will much more than counterbalance the diminution which arises from the centre of the plate being nearer to the pole. The effects that would be produced under these circumstances will be most evident, by considering how a dipping needle would be affected, and referring its deviations to the horizontal plane, remembering that in all cases an increase of dip causes an increase in horizontal deviation, and the contrary. When the centre of the plate is in south latitude longitude 90°, and in north latitude longitude 270°, the attraction of the plate tends to increase the dip, and to diminish it when in south latitude longitude 270°, and north latitude longitude 90°; so that in the former cases the deviation will be increased from this cause, and in the latter diminished. This effect was so great that in one instance the zero, or reading of the north end of the needle previous to rotation, corresponding to the point 240 on the plate, was 97° W, 36° E, after rotation in one direction, and 144° E, after rotation in the other, giving no less than 108° for the deviation due to rotation in opposite directions: corresponding to the point 180 on the plate, these were 86° 40′ E, 42° 10′ W, and 20° 10′ W, giving only 22° for the deviation due to rotation. By referring to Table I. in my Paper, it will be seen that there are indications of the same effect,

since in longitude 90°, the deviations in south latitude are greater than the corresponding ones in north latitude, and the reverse takes place in longitude 270°; but as the differences are very small, I, at the time of making the observations, rather attributed them to errors in the adjustment, than to any other cause.

When the centre of the plate was in the secondary to the equator and meridian, and its plane a tangent to the sphere, I had found the deviation due to rotation so small, that it might be considered to vanish: at Port Bowen, however, the absolute deviation was so great, that in some parts of this circle the deviation due to rotation became sensible; and it would appear that the locus of the points where this deviation vanishes is a line of double curvature, passing from the south pole on each side, a little north of the secondary, down to its intersection with the equator, and then a little south of the secondary to the north pole. The signs which I have prefixed to the deviations in Table IV. of Mr. FOSTER'S observations, indicate the course of this curve.

The whole of the results in Mr. FOSTER'S observations perfectly agree with the law which I have given in my Paper as embracing all the phenomena dependant upon rotation, and even the differences which I have noticed between my own observations and these, are precisely such as we should expect, according to this law, to be observable in a change of the complement of the dip from 20° to 2°.

The results obtained by the repetition of my experiments at Port Bowen, prove that the phenomena depending on rotation are by no means unimportant as connected with the practical problem of correcting the attraction of a ship on

the compass by means of an iron plate. Having observed the effects that were produced on the needle by the rotation of an iron plate previous to the sailing of the Leven and Barracouta, in the spring of 1822, these vessels being furnished with correcting plates, I communicated the discovery to Mr. BARLOW, and stated that probably the correction might be sensibly affected by it, unless rotation, in applying the plate, were prevented, by having the pin so formed that the plate could only be slid on. The preceding observations prove clearly the importance of attending to this, especially in high magnetic latitudes, should circumstances require the removal and replacing of the plate, since there can be no doubt, from the magnitude of the deviations arising from rotation, observed by Mr. FOSTER, that if in replacing the plate, it were made to revolve, although it might be in precisely the same situation as before, its magnetism would be so materially changed, that the attraction of the ship would no longer be corrected by it. Should such a circumstance take place, it may be proper to mention that the plate would be restored nearly to its original state, by allowing it to remain for some time with its plane in that of the magnetic equator.

S. H. CHRISTIE.

Royal Military Academy,
10th January, 1826.

IX. *Observations to determine the amount of Atmospherical Refraction at Port Bowen in the Years* 1824-25. *By Captain* W. E. PARRY, *R. N. F. R. S. Lieutenant* HENRY FOSTER, *R. N. F. R. S. and Lieutenant* J. C. ROSS, *R. N. F. L. S.*

To ascertain correctly by actual observation the amount of atmospherical refraction at low altitudes and at various states of the barometer and thermometer, is a problem which has long occupied the attention of practical astronomers; and many elaborate theories have also been given to explain the anomalies which have hitherto attended the most careful observations.

In Mr. IVORY's Paper, printed in the Philosophical Transactions for 1823, he states (page 495), that his table of refractions has been constructed merely with the view of comparing the theory in the paper with observation. He adds, however, "that it would be more satisfactory to determine "the same quantity (f) by the comparison of many observed "refractions at low altitudes between the distances of 85 "and 88 degrees from the zenith; and by this means a "table might be constructed that would be deserving of "greater confidence."

With a view, therefore, to supply the desideratum alluded to, three distinct series of observations were made at Port Bowen, by Captain PARRY, Lieutenant FOSTER, and Lieutenant ROSS; the details of which are given in the following Paper.

Various methods suggested themselves for the determination of this question. The first was to measure the zenith distance of known stars at a given moment, with the repeat-

ing circle, and then to have computed the true altitude; whence the actual refraction might have been deduced.

The difficulties, however, attending the use of the repeating circle, during the winter of the polar regions, have already been alluded to on several occasions, in the accounts of the two preceding voyages of discovery. The most material of these consist in the extreme contraction of the spirit in the long level, when filled in the usual way; the instantaneous freezing of the breath or other vapour on the glasses, obliging the observer to hold his breath during each observation; and the pain, amounting to the sensation, and producing the effects of burning consequent on touching intensely cold metal with the naked hand. The first of these was obviated, on the present occasion, by inserting a larger quantity of spirit than usual, so as to keep both ends of the bubble in sight, even during the most intense cold: this latter circumstance, however, afforded the opportunity of remarking an increased sluggishness in the level at very low temperatures, arising possibly from a certain degree of thickening in the spirit, which required the instrument to stand unmoved for at least two minutes after the contact had been made, in order to insure an accurate reading. It is unnecessary to point out, how unfavourable to minute accuracy this circumstance must prove, in observing an object having quick motion, either in altitude or in azimuth. A set of zenith distances, consisting of only eight observations, cannot, indeed, under such circumstances, be satisfactorily obtained in less than thirty-five or forty minutes. If to the difficulties already mentioned be added the annoyance sometimes experienced by the extinction of the lamp for illuminating the wires during an obser-

vation, in consequence of the freezing of the oil ; the frequent occurrence of snow drift ; and the haze which usually hangs near the horizon during a Polar winter, it must be admitted, that the repeating circle is not calculated, under such circumstances, either for obtaining numerous observations, or for ensuring the degree of accuracy indispensibly requisite in observations for determining the amount of atmospherical refractions.

Another method was suggested by Captain KATER, in April, 1824, which is explained in the following words :

" Select a star which passes the zenith, and when this star " and the Pole star are at the same altitude, take the distance " between them by means of the repeating reflecting circle ; " do the same when the star is in the zenith, and also when " upon the meridian under the Pole. From the first observa- " tions the true zenith distance of the stars may be readily " obtained. By observations made when the star is in the " zenith, the absolute refraction of the Pole star will be " given, and from the observations made when the star is " under the Pole, the refraction at that altitude can be easily " deduced. Pursue the same method with other stars, care- " fully marking at each observation the *time* and state of the " *barometer* and *thermometer*. We shall thus be furnished with " data, from which the refraction at the various altitudes can " be computed with facility and accuracy."

On considering, however, the difficulties already detailed in the use of the repeating circle, which rendered it impossible to take advantage of this ingenious suggestion of Captain KATER ; it occurred to Lieutenant FOSTER, that a more simple and accurate method of determining the amount of refraction,

would be to observe the setting of stars within certain limits of azimuth, behind the high land which encircles this harbour, and then determining at leisure the zenith distance of that part behind which the star set. As the ruggedness of the land, however, combined with the frequent alteration of the star's azimuth, would materially affect results thus obtained; Captain PARRY proposed, as a modification of this idea, to place a board edge-wise, and strictly horizontal, on the spot behind which the star set, thus rendering it unimportant upon what part of the board the occultation of the object took place, as well as affording more ready means of obtaining its apparent altitude.

Two boards were accordingly fixed with all possible firmness and accuracy upon a neighbouring hill, to the westward of the observatory, for observing the setting of α Aquilæ and Arcturus respectively, the board for the former being on a N $75°\frac{1}{2}$ W bearing, distant 924 feet, and for the latter N 40° W, 1590 feet.

The observations by Captain PARRY, given in Tables II. and VI., were made with a small theodolite, having its legs immoveably fixed by freezing, across a cask filled with sand; those in Table IV. by a ship telescope, two feet in length, securely attached to the cask itself, and having no motion whatever.

Lieutenant FOSTER's observations contained in Tables VIII. to XI. inclusive, were made with a small repeating circle by DOLLOND, furnished with two telescopes, which afforded the means of obtaining double observations of each star the same evening. This instrument stood 122 feet above the level of the sea, on a cask filled with sand, firmly frozen to the ground, and was secured from the weather by a suitable covering.

The observations by Lieutenant Ross, in Tables XIII. to XV. inclusive, were obtained with a small variation transit instrument as an upper telescope, and those in Tables XVI. and XVII. by a pocket telescope below; both being fixed to a cask filled with sand. None of the instruments used by either of the three observers were removed, till after the completion of the whole series of observations.

The hour angle by which the true altitude of the setting star was determined, was obtained by taking its right ascension from that of the meridian, at the time of observation, as found by transits of well known stars, which took place within three quarters of an hour of the other star's setting, thus rendering the observations as independent as possible of any want of uniformity in the rates of the pocket chronometers employed by the observers. The transits were taken exclusively by Lieutenant FOSTER, and comparisons with the chronometer he employed, were taken by the other observers about the time of transit, in order to deduce their horary angles, contained in the respective Tables. The position of the transit instrument was rigidly verified by the transits of high and low stars in their passages across the meridian, as well as by a constant reference to a meridian mark, and by the most minute attention to the level. The heights of the barometer, and of the thermometer, suspended with its bulb on the same level with the observers in the open air, were taken at the time of every observation. The registered height of the barometer, however, in the Tables, has been corrected for instrumental errors, and brought up to a certain temperature, which is specified at the head of each of the columns containing it.

The latitude, 73° 13′ 39″,4 N.* used in these computations, is the result of 91 sets of observations on Polaris, at different horary distances from the north and south meridians, by Captain PARRY and Lieutenant FOSTER; employing Dr. YOUNG's Table of Atmospherical Refractions, published at the end of the Nautical Almanack for each year.

As soon as the sun afforded sufficient light for obtaining the apparent altitudes of the boards from the respective telescopes, observations were commenced for that purpose. The circle used by Lieutenant FOSTER afforded the direct means of doing this, for the upper telescope, by which the zenith distance of the edge of the board at the spot where the star set, was at once obtained by observation. The angular distance between this telescope and the lower one, as seen from the board, was determined by means of a double wire micrometer, attached to one of DOLLOND's achromatic telescopes 46 inches focal length, the object-glass of which was let into the board, so as to make its centre exactly coincide with that part behind which the star set.

The telescopes employed by Captain PARRY and Lieutenant Ross, not being attached to an instrument calculated for measuring zenith distances, required some further contrivance to obtain the altitudes of the boards with respect to them. In order to place the repeating circle precisely at the same altitude with Captain PARRY's upper telescope, a levelling staff was fixed into the ground, half way between the place of observation and the board. This being adjusted by sliding up or down till a fine brass point on its upper end exactly

* The elements of this result, are given in the Appendix to Capt. PARRY's Narrative of the Third Voyage for the Discovery of a North West Passage into the Pacific Ocean.

coincided with the edge of the board, when seen through the upper telescope; the repeating circle was also raised or lowered until the same coincidence obtained, when looking through *its* telescope. The accuracy of the position thus obtained was finally verified by observing the setting of the star, through each telescope, when it was found to disappear to both observers at the same instant.

For the altitude of the board, with respect to the lower telescope used by Captain PARRY, a short staff, exactly equal in length to the measured distance between the telescopes, was fixed vertically above the board, and the zenith distance of its well defined top observed by the repeating circle in its former place. And as a confirmation of the results thus obtained, the method described above, as adopted by Lieutenat FOSTER, by means of the micrometer, was also resorted to; a mean of the two methods (which differed $2''{,}8$), being used in the computation of the refractions. Lieutenant Ross's zenith distances were obtained by a repeating circle, placed on the same cask which held the telescopes he employed, the angular distance between each of these, and that of the circle (when directed to the board), being determined by repeated observations with the micrometer, fixed upon the respective boards in the manner already described. In some instances, Lieutenant Ross observed the re-appearence of α Aquilæ under the board, thus obtaining an observation at another altitude. The corresponding zenith distance of that part of the board was determined by measuring with the micrometer, the angle subtended by the board at the place of observation.

The zenith distances of the boards, as obtained by the

respective observers, are given in the Tables attached to the corresponding observations for refraction, except those of Lieutenant Ross, the details of which, were unfortunately left on board the Fury at the time of her loss.

While making the above mentioned observations for the zenith-distances of the boards, Captain PARRY had occasion to notice, on the 28th of February, some anomalies which had never before occurred, and which were at first attributed to some slight and imperceptible change in the position of the repeating circle (see Table III.) On continuing the observations, however, it soon appeared that the changes coincided nearly with particular times of the day, the greatest zenith distance always occurring when the thermometer stood the highest, and the weather was most calm. To clear the zenith distances of this effect of refraction, the repeating circle was carried up the hill, the object-glass of its telescope being placed in a notch cut in the board, as already described above in using the micrometer; when by several days' observations, continued from morning till night, it was found that the same phenomenon as before occurred, the zenith distance of the station below uniformly increasing from the morning till the afternoon, and again decreasing as the sun fell. Two sets of observations taken at the board after midnight, by means of a lamp viewed through the tube of the telescope, at the lower station, gave nearly a mean of all the other observations. Thus it appeared that whether observed from the top or the bottom of a hill whose altitude was $4^{\circ}\frac{1}{2}$, an increase of zenith distance (varying from $9''$ to $17''$), took place about the same hours, indicating a comparatively rare medium near the surface of the ground, and giving such a curvature to the visual ray, as to produce a similar effect at both stations.

Table I.

Observations for determining the Apparent Altitude of Arcturus at Setting, by Captain Parry, 1824-5.

The corresponding Observations for Refraction are contained in Table II.

Day.	Time.	No. of Observations.	Mean Reading of the four Verniers.	Correction for Index.	Correction for Level.	Apparent Altitude.	Barom. Corr. to Temp. + 50°	Temp. Faht.	Velocity of Winds.	Weather.	Remarks.
1825.			° ′ ″	″	′ ″	° ′ ″	Inches.	°			
Mar. 23rd	6h to 6h 40m A. M.	8	299 45 55	+10	— 18,75	7 31 46,72	30,353	—36,5	Lt. variable	Very clear &	⊙ not risen.
	7h to 7h 40m A. M.	8	239 31 43	*	— 13,75	48,22	.....	—35	Airs	Fine	⊙ not on the instrument.
	9h 10m to 10h A. M.	8	179 17 22,5	•	+ 9,75	46,34	30,348	—31	Ditto	Ditto	⊙ on the instrument.
	Noon to 0h40mP.M.	8	299 47 18,75	+13	+ 29,75	37,25	30,349	—25 in ⊙—16	Ditto	Ditto	Ditto.
	1h15m to 2h30m P.M.	8	239 33 44,5	•	+1 29	30,66	.....	—26 ⊙—12	Ditto	Ditto	Do. some waving at the board.
	3h 10m to 4h P. M.	8	299 46 52,5	+10	+ 8,25	36,16	30,343	—27	Ditto	Ditto	Ditto Ditto
	4h40m to 5h15m P.M.	8	239 34 10	*	— 23,75	38,28	30,330	—30	Ditto	Ditto	Instrument partly shaded.
	5h30m to 6h 10m P.M.	8	299 46 55	+10	— 9,5	38,06	.....	—31	Ditto	Ditto	Ditto quite shaded.
Mar. 24th	6h20m to 6h55m A.M.	8	299 45 57,5	+10	+ 18,25	41,78	30,355	—37	Light air	Clear & fine	⊙ not risen.
	1h 15m to 2h P. M.	8	299 47 15	+10	+ 21,5	31,69	30,386	—28 ⊙—15	Easterly	Ditto	Instrument skreened from ⊙.
	2h10m to 2h40mP.M.	8	239 33 54	*	+ 48,75	34,03	.....	—29 ⊙—19½	Ditto	Ditto	Ditto by a snow wall.
	4h30m to 5h30mP.M.	8	299 47 27,5	+ 5	— 22	36,19	30,380	—32	Ditto	Ditto	Ditto Ditto
Mar. 25th	6h10m to 6h50m A.M.	8	299 46 37,5	+10	— 30,25	42,84	30,397	—38,5	Light airs	Fine & clear	The instrument quite shaded by a wall of snow.
	1h to 1h 40m P. M.	8	299 45 42,75	+10	+1 00,75	38,31	30,396	—32	Ditto	Ditto	
	2h to 2h 40m P.M.	8	239 32 45,75	*	+ 12,75	35,53	30,387	—30	Ditto	Ditto	
	5h15m to 6h15mP.M.	8	179 19 02,5	•	— 13,75	44,63	30,393	—32	Ditto	Ditto	Ditto.
Apr. 2nd	4h40m to 5h20m A.M.	8	299 46 21,5	+ 7,5	— 24,5	44,44	29,938	—35	Wind	Clear	⊙ not risen.
	1h30m to 2h15m P. M.	8	299 47 08,75	+ 7,5	— 19,75	37,94	29,889	—23 ⊙—20	Fresh and Cold	Ditto	Instrument skreened from ⊙.
	2h30m to 3h10mP.M.	8	239 34 27,5	*	— 7	36,03	29,881	—23	Ditto	Ditto	Ditto.
	6h 30m to 7h P. M.	8	299 47 38,75	+ 7,5	— 12	33,22	29,875	—28	Ditto	Ditto	⊙ on instrument.
Apr. 6th.	2h to 2h 40m P. M.	8	299 47 37,5	+ 7,5	— 7	32,75	30,104	—22 ⊙—16	Light	Ditto	

Mean apparent altitude 7° 31′ 38″,62 used for the refractions in Table II.

• The index not reset to 360°.

Table II.

Observations for the Atmospheric Refraction observed by the setting of Arcturus, 1824-5, by Captain Parry.

Apparent Altitude 7° 31′ 38″,62.

Day.	Time of Arcturus setting by No. 2.	Transit Observed. Star.	Transit Observed. Time reduced to No. 2.	Rate of No. 2. losing.	Arcturus's Horary ∠ at setting.	Arcturus's True altitude.	Observed Refraction.	Barom. Corr. to Temp. + 50°	Temp. Fah^t.	Winds.	Weather.	Remarks.
1824.	h. m. s.		h. m. s.	s	h. m. s.	° ′ ″	′ ″	Inches.	°			
Nov. 28th	0 33 45,3	α Andromeda	1 14 48,08	1,0	9 10 32,82	7 23 50,3	7 48,32	29,936	− 5			
Dec. 1st	0 22 01	α Arietis	3 00 37,54	1,0	9 10 38,21	7 23 34,7	8 03,92	30,083	20	Easterly Fresh	Very Clear	
2d	0 26 49,5	Ditto	3 05 23,34	1,24	9 10 40,85	7 23 27,4	8 11,22	29,946	21	Ditto Light	Ditto	
5th	0 14 59,7	α Andromeda	0 55 51,86	1,24	9 10 43,20	7 23 21,75	8 16,87	939	21	Ditto Ditto	Ditto	
6th	0 10 59,2	Ditto	0 51 54,91	1,24	9 10 39,69	7 23 29,2	8 09,42	786	18,8	Ditto Ditto	Ditto	
7th	0 07 01	Ditto	0 47 57,95	1,24	9 10 38,42	7 23 32,5	8 06,12	517	11	NNE Fresh	A few fleecy clouds, star clear.	
8th	0 03 05	Ditto	0 44 00,85	1,24	9 10 39,53	7 23 29,2	8 09,42	501	19,5	NE Light	Very clear	
9th	11 59 10	Ditto	12 40 03,36	1,24	9 10 41,85	7 23 22,5	8 16,12	719	18,5	NNE Ditto	Ditto	
10th	11 55 04	Ditto	12 36 07,5	2,22	9 10 31,64	7 23 50,2	7 48,42	683	11,5	Ditto Fresh	Rather hazy near horizon.	
11th	11 51 10	Ditto	12 32 08,26	2,22	9 10 36,86	7 23 35,8	8 02,82	610	15,2	NW Fresh	Clear	
13th	11 43 18,2	Ditto	12 24 11,9	2,22	9 10 41,32	7 23 22,8	8 15,82	30,001	24,5	North Moder.	Very clear	
14th	11 39 24	Ditto	12 20 13,9	2,22	9 10 45,09	7 23 08,6	8 30,02	152	27,2	WNW Ditto	Ditto	
15th	11 35 30,5	Ditto	12 16 15,13	2,22	9 10 50,35	7 23 57,5	8 41,12	337	35	NE Light	Ditto	[South.
20th	11 15 27	α Arietis	13 54 04,46	1,97	9 10 36,6	7 23 34,3	8 04,32	29,619	23,5	North Fresh	Ditto except near horizon. Aurora in	
21st	11 11 37	α Andromeda	11 52 27,45	1,97	9 10 44,28	7 23 12,8	8 25,82	807	28,2	Ditto Light	Clear	Aurora faint S W.
22d	11 07 38	Ditto	11 48 29,96	1,97	9 10 42,72	7 23 16,9	8 21,72	877	29	Easterly Ditto	Ditto	Ditto Ditto
23d	11 03 47	Ditto	11 44 33,96	1,97	9 10 47,68	7 23 03	8 35,62	801	31	Calm	Ditto	Star not very distinct.
26th	10 51 48,5	Ditto	11 32 43,13	0,73	9 10 39,91	7 23 23,6	8 15,02	989	27,8	ENE moderate	Ditto	Aurora faint SS.W.
29th	10 39 56	Ditto	11 20 52,75	0,73	9 10 37,71	7 23 21,6	8 17,02	637	16,5	East Light	Very Clear	
1825.												
Jan. 2d	10 23 59	Ditto	11 04 51,95	3,25	9 10 41,17	7 23 18,5	8 20,12	881	29,4	Ditto Ditto	Clear	
3d	10 20 03	α Arietis	12 58 34,5	3,25	9 10 41,88	7 23 15,5	8 23,12	835	31,7	Ditto Ditto	A few thin clouds. Star quite clear.	
4th	10 15 59	α Andromeda	10 56 56,62	3,25	9 10 36,39	7 23 30,25	8 08,37	487	27	ENE Squally	Some haze	Star distinct.
5th	10 12 05,5	Ditto	10 52 59,63	3,25	9 10 39,86	7 23 20,6	8 18,02	338	36,5	Easterly Light	Ditto	Indifferent observation.
6th	10 08 13	Ditto	10 49 01,7	3,25	9 10 45,88	7 23 03,6	8 35,02	269	32,2	Northerly D°.	Tolerably Clear	Star distinct.
7th	10 04 12,5	Ditto	10 45 04,1	2,11	9 10 42,33	7 23 13,4	8 24,22	529	35,5	Easterly Ditto	Quite Clear	
10th	9 52 20	Ditto	10 33 10,43	2,11	9 10 43,48	7 23 46,7	8 51,92	962	35,5	Ditto Ditto	Very Clear	
11th	9 48 26	Ditto	10 29 13,25	2,11	9 10 46,53	7 23 00,7	8 37,92	30,140	38,3	Ditto Ditto	Ditto	
12th	9 44 26,5	Ditto	10 25 14,23	2,11	9 10 46	7 23 02	8 36,62	29,954	38,4	ENE Ditto	Ditto	
15th	9 32 32	Ditto	10 13 20,85	2,5	9 10 44,75	7 23 05,2	8 33,42	711	27,5	Easterly Ditto	Ditto	
16th	9 28 29,5	Ditto	10 09 20,78	2,5	9 10 42,27	7 23 11,7	8 26,92	730	31,2	Ditto Ditto	Ditto	Some twilight westward.
17th	9 24 30,6	Ditto	10 05 19,71	2,5	9 10 44,39	7 23 05,8	8 32,82	638	28	Ditto Mod.	Rather hazy	Star distinct, good obser^n.
24th	8 13 12	Ditto	8 53 54,56	6,02	9 10 50,55	7 23 47,4	8 51,22	822	37,2	NEasty. Light	Tolerably Clear	Star quite distinct.
25th	8 09 06	α Pegasi	7 46 45,57	6,02	9 10 45,24	7 23 01,8	8 36,82	795	42,2	Ditto Ditto	Very Clear	Strong twilight westward.
27th	8 00 55,5	Ditto	7 38 42,5	6,02	9 10 37,74	7 23 20,1	8 18,52	846	27	NW Fresh	Clear and Drift	Star quite clear.
					Means		8 23,95	29,791	− 23,58			

Table III.

Observations for determining the apparent altitude of *a* Aquilæ at setting, by Captain PARRY's *upper* telescope. The corresponding observations for refraction are contained in Table IV.

Day.	Time.	No. of Observations.	Mean Reading of the four Verniers.	Correction for Index.	Correction for Level.	Apparent Altitude.	Barom. Corr. to Temp. + 50°.	Temp. in Shade Faht.	Winds True.	Weather.	Remarks.
1825.	h m		° ′ ″	″	″	° ′ ″	Inches.	°			
Feb. 2d	10 30 A. M. to 2 P. M.	8	323 40 12,5	+10	— 2,25	4 32 27,47	30,04	—39,5	Easterly very light	Very clear	The sun did not rise upon the board till the 12th, nor on the place of observation till the 14th.
		8	323 41 10	+10	—34,5	24,31	....	—40,5		Hazy	
5th	11 to Noon.	8	323 41 07,5	+10	—40,5	25,37	29,05	—26	NNE Fresh	Clear & fine	
11th	1 to 2 P. M.	8	323 40 15	+ 7,5	+21,5	24,53	30,15	—31,5	Easterly Light		
15th	Noon to 1 P. M.	8	323 40 30	+11,25	— 8	25,84	29,65	—31,5	NortherlyLight	Hazy	
March 5th	10 30 to 11 30 A. M.	8	323 37 53,25	+ 7,5	+40,5	39,84	29,90	—18	Easterly very light		
	0 to 0 40 P. M.	8	287 18 17,5	*	—1′08,25	35,5	....	—19		Clear and warm	
	0 45 to 1 30 P. M.	8	250 56 35,75	*	+24,75	39,62	....	—19			
	1 25 to 2 15 P. M.	8	214 36 37,5	*	— 8	30,78	....	—18,5			
	about sunset.	8	178 16 32,5	*	—11,75	32,04	29,93	—19			
	Mean of observations at lower station					4 32 30,53					
All the following observations were made at the upper station.											
March 7th	h m 10 30 A. M. to 0 40 P. M.	20	90 54 40	+10	+10,25	4 32 45,01	30,19	—35	Varia. & Light	Clear	Sun bright and very warm.
8th	10 A. M. to Noon.	20	90 51 57,5	0	—1′47,75	30,49	29,98	—27	Easterly Light	Cloudy	
	0 to 2 P. M.	20	181 46 12,5	*	—1′26,25	38,44	....	—27	.....	⊙breaking through the clouds.	
	2 to 4 30 P. M.	20	272 36 48,75	*	—50,75	29,27	30,00	—28,5	.....	⊙ obscured	
10th	11 A. M. to 0 30 P.M.	10	225 24 34,25	+10	+27,25	31,13	30,26	—28	Nearly calm weather	Very clear	
	0 46 to 1 50 P. M.	10	90 50 13,75	*	+1′20	41,95	....	—29		Ditto	
	2 to 2 55 P. M.	10	316 14 29,25	*	+1′16,25	33,17	30,28	—29		Clear	
	3 10 to 4 15 P. M.	10	181 40 17,5	*	—32	31,62	....	—30	Ditto	Ditto	
	4 15 to 5 40 P. M.	6	28 54 32,5	*	+29	27,33	30,30	—30,5	Ditto	Ditto	
11th	6 30 to 7 40 A. M.	10	225 23 17,5	+ 6,2	+18,25	22,19	30,37	—37	Fine and nearly calm throughout the day		
	7 50 to 8 40 A. M.	8	261 43 03,75	*	+ 9	29,41	30,38	—35			
	9 45 to 10 40 A.M.	10	225 23 42,5	+10	+31	26,35	....	—34			
	Noon to 1 P. M.	10	‡67 39 58,75	*	+22,25	31,35	30,39	—29			
	1 25 to 2 30 P. M.	10	293 05 15	*	+26,25	34,25	30,34	—28			
	3 10 to 4 P. M.	8	36 20 58,75	+12,5	—30,25	35,13	....	—29			
	4 50 to 5 30 P. M.	10	†64 26 32,5	*	—35,25	26,22	30,35	—33			
12th	6 30 to 7 30 A. M.	10	225 24 38,75	+ 7,5	—25,75	26,05	30,20	—35,5	Ditto	Ditto	Western land much refracted.
	11 45 to 0 35 P. M.	10	225 25 30	+ 6,5	+28,25	36,47	30,12	—27			
	2 50 to 3 30 P.M.	10	††67 44 05	*	+59,5	39,20	30,05	—27,5			
	4 10 to 4 50 P. M.	10	‡‡95 51 17,5	*	—55	33,75	30,02	—31			
14th	6 15 to 7 15 A. M.	8	36 19 50	+ 6,2	—71,5	20,59	29,79	—35	.....	.....	⊙ rose towards the conclusion.
	1 30 to 2 30 P. M.	10	202 19 05,5	**	+ 7	37,80	75	—26,5	Ditto	Ditto	
	4 20 to 5 40 P. M.	12	54 29 51,25	+ 7,5	—45,5	26,10	76	—30			
21st	10 40 to 11 50 P. M.	8	36 21 17,5	+10	—58,75	33,59	29,90	—33	Calm	Very clear	
22d	0 till 1 A. M.	8	72 42 12,5	*	— 3,25	36,47	....	—35			
	Mean of 2 sets taken at night at the upper station					4 32 35,03					

* Index not reset to 360° after the last observation.
‡ Index not reset after an observation for another object. Index error 202° 15′ 07″,5.
† Ditto - - - - - - - 199 01 35.
†† Ditto - - - - - - - - 202 18 32,5.
‡‡ Ditto - - - - - - - - 230 24 45.
** Ditto - - - - - - - 336 52 54,5.

	Altitude.
	° ′ ″
Mean of 80 zenith distances taken at the lower station	4 32 30,35
Mean of 278 at the upper station - -	4 32 32,13
Mean of both stations by day - -	4 32 31,67
Mean of 16 zenith distances taken at night -	4 32 35,03
Mean of all the above -	4 32 32,34

used in computing the refractions in Table IV.

Table IV.

Observations for the Atmospheric Refraction observed by the setting of α Aquilæ 1824-5, by Captain Parry.

Apparent Altitude 4° 32′ 32″,34.

Day.	Time of α Aquilæ setting by No. 2.	Transit Observed. Star.	Transit Observed. Time reduced to No. 2.	Rate of No. 2. Losing.	α Aquilæ. ∠ Horary at setting.	α Aquilæ. True Altitude.	Observed Refraction.	Barom. Corr. to Temp. +50°.	Temp. Fahᵗ.	Winds True.	Weather.	Remarks, &c.
1824.	h. m. s.		h. m. s.	s.	h. m. s.	° ′ ″	′ ″	Inches.	°			
Dec. 8th	3 18 48,5	α Arietis	2 41 40,38	1,24	6 52 21,35	4 19 44,8	12 47,54	29,544	−18	NNE Fresh	Very Clear	
10th	3 10 48	αAndromedæ	0 36 07,55	2,22	6 52 14,45	20 10,8	12 21,54	564	14	Northerly Light	Ditto	
11th	3 06 51	α Arietis	2 29 48,2	2,22	6 52 16,05	20 05,5	12 26,84	707	14	NNW Fresh	Clear	
13th	2 59 06,5	Ditto	2 21 51,23	2,22	6 52 28,54	19 13	13 19,34	30,056	25	North Light	Very Clear	
16th	2 49 14,5	Aldebaran	4 38 06,79	2,22	6 52 30,65	19 03,8	13 28,54	098	35	ENE Ditto	Ditto	Aurora faint SW.
20th	2 31 17	α Arietis	1 54 03,56	1,97	6 52 26,65	19 19,8	13 12,54	29,674	26,3	North Ditto	Ditto	Ditto. [ward.
21st	2 27 20	Ditto	1 50 06,77	1,97	6 52 26,44	19 20,8	13 11,54	800	26,8	Ditto Fresh	Clear	Do. bright to the south-
22d	2 23 23	Ditto	1 46 09,38	1,97	6 52 26,81	19 19,2	13 13,14	837	27,2	SW Light	Ditto	Do. faint in SW.
23d	2 19 26	Ditto	1 42 13,26	1,97	6 52 25,93	19 22,3	13 10,04	810	32	Calm	Very Clear	Ditto Ditto.
26th	2 07 30	Ditto	1 30 21,96	0,73	6 52 21,15	19 42,2	12 50,14	987	26,5	.....	A little haze near horizon,	
29th	1 55 35	Ditto	1 18 31,43	0,73	6 52 16,66	20 00,7	12 31,64	666	16	Easterly Light	Ditto	Star quite distinct.
1825.												
Jan. 2d	1 39 42	Ditto	1 02 32,13	3,25	6 52 22,93	19 32,3	13 00,04	847	30	Ditto Ditto	A few thin clouds	Ditto
3d	1 35 49	Ditto	0 58 33,8	3,25	6 52 28,24	19 10,3	13 21,73	828	33	Ditto Ditto	Ditto	Ditto
5th	1 27 49,3	Ditto	0 50 38,56	3,25	6 52 23,55	19 29,8	13 02,54	356	35,5	Ditto Ditto	A little haze	Ditto
6th	1 23 49	Ditto	0 46 40,86	3,25	6 52 20,91	19 44,4	12 47,94	322	32,2	NE Ditto	Ditto Eastward	Ditto
10th	1 08 06,2	Ditto	0 30 50,28	2,11	6 52 28,60	19 07,5	13 24,84	30,054	35,5	Easterly Ditto	Very Clear	
11th	1 04 12,2	Ditto	0 26 51,01	2,11	6 52 33,89	18 45	13 47,34	127	39,3	Ditto Ditto	Ditto	
12th	1 00 09	Ditto	0 22 52,86	2,11	6 52 28	19 06,3	13 26,04	29,983	38,7	Ditto Ditto	Ditto	
17th	0 40 17	Ditto	0 02 59,46	2,5	6 52 30,09	19 00,2	13 32,14	623	26,5	Ditto Fresh	Clear over head	Drift below, star distinct.
20th	12 28 05,5	Ditto	11 50 56,47	2,3	6 52 21,70	19 35	12 57,34	372	29	Northerly Light	Very Clear	Aurora faint to south-
25th	11 24 49,5	Ditto	10 47 33,32	6,02	6 52 28,81	19 04,5	13 27,84	787	43,2	Easterly Ditto	A few Clouds	Star very distinct. [ward.
27th	11 16 45,5	Ditto	10 39 30,03	6,02	6 52 28,05	19 06,7	13 25,64	833	28,2	NW Fresh	Very Clear	
Feb. 2d	10 50 34,5	Ditto	10 13 14,08	5,91	6 52 32,94	18 46	13 46,34	224	41,2	Easterly Mod.	Ditto	
7th	10 30 10	Ditto	9 53 03,44	5,7	6 52 18,59	19 45,5	12 46,84	583	26,5	Calm	Ditto	Twilight westward.
8th	10 26 24	αAndromedæ	7 51 21,35	5,7	6 52 35,89	18 32,8	13 59,54	749	37	Ditto	Ditto	Good Ditto Ditto
9th	10 22 17,8	α Arietis	9 45 00,75	5,7	6 52 28,77	19 02,5	13 29,84	960	37,7	Easterly Light	Ditto	Ditto Ditto
11th	10 14 16,7	αAndromedæ	7 39 19,13	5,7	6 52 30,71	18 54,3	13 38,04	30,154	34			
						Means	13 12,51	29,761	−29,94			

Table V.

Observations for determining the Apparent Altitude of α Aquilæ at setting, by Captain PARRY's *lower* telescope.

The corresponding observations for Refractions are contained in Table VI.

Day.	Time.	No. of Observations.	Mean Reading of the 4 Verniers.	Correction for Index.	Correction for Level.	Apparent Altitude.	Barom. Corr. to Temp. + 50°.	Tem. Fah^{t}.	Winds True.	Weather.	Remarks.
1825.	h. h.		° ′ ″	″	″	° ′ ″	Inches.	°			
Feb. 16th	1 to 2 P.M.	8	322 48 33,75	+10	−10,25	4 38 55,81	29,831	−36	Easterly	Fine	⊙ had been on the board just before the observation.
	2 to 3 P.M.	8	285 37 12,5	*	−16,25	57,19	29,831	−34½	Easterly		
18th	8 to 9 A.M.	8	322 48 00	+2,5	+29,25	56,03	29,608	−29	Easterly	Clear	⊙ not up.
	2½ to 4 P.M.	8	285 35 12,5	*	+1′24,25	55,41	29,645	−26½	Easterly	Ditto	⊙ had set.
22d	8 to 9 A.M.	8	322 48 12,5	+10	−12,25	58,72	29,791	−30	ESE	Ditto	⊙ not on the board.
			Mean altitude by repeating circle			4 38 56,63					
			Ditto for upper telescope....			4 32 32,34	See Tab. III.				
			Difference of the two telescopes by zenith distances			6′ 24″,29					

Observations by the micrometer, to obtain the angular distance between the two telescopes used for observing the setting of α Aquilæ. The telescope placed on the board as before described.

March 12th, 1825.

From 10^{h} 30^{m} to 11^{h} 30^{m} A. M.

Upper wire] fixed.	Lower wire moved.
61,2	45,8
58,8	50,6
59,2	53
60,2	46,3
60,9	48,8
62,3	51
60	49
62	49,4
61	49,3
63	49,3
60,86	49,25
49,25	
11,61	

+ 8 turns of the screw = 811,61 divisions.

811,02 = + 8 turns

Mean 811,31 × 47′ 7″ (the value of each division) = 6′ 27″,09.

From Noon till 1^{h} 0^{m} P. M.

Upper wire fixed.	Lower wire moved.
32	43
32,5	44
31,5	43,2
33,2	43,8
32,3	48
33,8	43
32,8	43,8
36,8	45
36,2	47
37	47,5
33,81	44,83
	33,81
	11,02

Difference of altitude between the two telescopes by the repeating circle.....6′ 24″,29

by the micrometer.....6 27 ,09

Mean .....6 25 ,69

Altitude observed for the upper telescope (Table III.)..... 4 32 32 ,34

Altitude for lower telescope, used for the refractions, in Table VI..... 4 38 58 ,03

Table VI.

Observations for the Atmospheric Refraction, observed by the setting of α Aquilæ, 1824-5, by Captain Parry.

Apparent Altitude 4° 38′ 58″,03.

Day.	Time of α Aquilæ setting by No. 2.	Transit observed. Stars.	Transit observed. Time reduced to No. 2.	Rate of No. 2 losing.	α Aquilæ. Hor. ∠ at setting.	α Aquilæ. True altitude.	Observed Refraction.	Barom. Corr. to Temp. + 50°.	Temp. Fah^{t}.	Winds True.	Weather.	Remarks.
1824.	h. m. s.		h. m. s.	s.	h. m. s.	° ′ ″	′ ″	Inches.	°			
Dec. 20th	2 29 43,5	α Arietis	1 54 03,56	1,97	6 50 52,89	4 25 52,3	13 05,73	29,674	—26,3	North Light	Very clear	Aurora faint.
21st	2 25 46	Ditto	1 50 06,77	1,97	6 50 52,17	25 55,4	13 02,63	800	26,8	Do. Fresh	Do.	Do. bright to southward.
22d	2 21 47	Ditto	1 46 09,38	1,97	6 50 50,54	26 01,8	12 56,23	837	27,2	SW Light	Do.	Do. faint in SW.
23d	2 17 50,5	Ditto	1 42 13,26	1,97	6 50 50,16	26 04,4	12 53,63	810	32	Calm	Do.	Do. Do.
26th	2 05 55,5	Ditto	1 30 21,96	0,73	6 50 46,39	26 19	12 39,03	987	26,5	.....	Clear, except near the horizon.	
29th	1 54 00	Ditto	1 18 31,43	0,73	6 50 41,39	26 39,4	12 18,63	666	16	Easterly Light	Do. a thin haze near horizon.	
1825												
Jan. 2d	1 38 08	Ditto	1 02 32,13	3,25	6 50 48,66	26 07	12 51,03	847	30	Do. Do.	Do.	Moonlight.
3d	1 34 11	Ditto	0 58 33, 8	3,25	6 50 49,94	26 01,5	12 56,53	828	33	D.. Do.	Do. a few thin clouds; star distinct.	
5th	1 26 16,3	Ditto	0 50 38,56	3,25	6 50 50,19	26 00,3	12 57,73	356	35,5	Do. Do.	Do. a little haze	Do.
6th	1 22 17	Ditto	0 46 40,86	3,25	6 50 48,66	26 06,4	12 51,63	322	32,2	NE Do.	Do. Do.	Do.
10th	1 06 33	Ditto	0 30 50,28	2,11	6 50 55,15	25 38,6	13 19,43	30,054	35,5	Easterly Do.	Very clear	
11th	1 02 36,5	Ditto	0 26 51,01	2,11	6 50 57,93	25 33,3	13 24,73	127	39,3	Do. Do.	Do.	
12th	0 58 37	Ditto	0 22 52,86	2,11	6 50 56,55	25 36	13 22,03	29,983	38,7	Do. Do.	Do.	[star not very clear.
15th	0 46 38	Ditto	0 11 00,16	2,5	6 50 50,18	25 58,4	12 59,63	735	28	Do. Do.	Do.	Aurora to the southward at times,
16th	0 42 38	Ditto	0 06 59,86	2,5	6 50 50,42	25 57,7	13 00,33	758	32,8	Do. Do.	Do.	Aurora faint to southward.
17th	0 38 39	Ditto	0 02 59,46	2 5	6 50 51,82	25 51,9	13 06,13	623	26,5	Do. Fresh	Clear	Some drift.
20th	12 26 29,5	Ditto	11 50 56,47	4,	6 50 44,44	26 22,9	12 35,13	372	29	North Light	Do.	Aurora faint to southward.
25th	11 23 14,5	Ditto	10 47 33,32	6,02	6 50 53,54	25 43,6	13 14,43	787	43,2	Easterly Do.	Do.	
27th	11 15 11	Ditto	10 39 30,03	6,02	6 50 52,99	25 45,3	13 12,73	833	28,2	NW Fresh	Do.	
Feb. 2d	10 48 58.2	Ditto	10 13 14,08	5,91	6 50 56,38	25 32,3	13 25,73	30,224	41,2	Easterly mod.	Very clear	
7th	10 28 33,5	Ditto	9 53 03,44	5,7	6 50 41,92	26 30,3	13 27,73	29,583	26,5	Calm	Do.	Some twilight.
8th	10 24 44,6	α Andromed.	7 51 21,35	5,7	6 50 56,21	25 32,2	13 25,83	749	37	Do.	Do.	Good Do.
9th	10 20 42	α Arietis	9 45 00,75	5,7	6 50 52,71	25 46,8	13 11,23	960	37,7	Easterly Light	Do.	Do. Do.
11th	10 12 44,2	α Androm preceding day	7 39 19,13	5,7	6 50 57,94	25 22,6	13 35,43	30,154	34	Do. Do.	Do.	Do. Do.
						Means	13 4,72	29,795	—31,8			

Table VII.

Observations for determining the apparent Altitude of Arcturus at the time of setting, by Lieutenant Foster's *upper* telescope.

The corresponding Observations for Refraction are contained in Tables VIII. and IX.

1825. Day.	Time.	No. of Obs.	Mean Reading of the four Verniers.	Correction for Index.	Correction for Level.	Apparent Altitude.	Barom. at Temp. + 48°.	Tem. Fah^{t}.	Winds. True.	Weather.	Remarks.
	h.		° ′ ″	″	″	° ′ ″	Inches.	°			
Feb. 18th	At 10 A.M.	16	238 34 17,5	+10,0	+17,75	7 35 19,67	29,540	—26	ESE Lt.	Fine & clear	
—*19th	11 A.M.	12	147 31 2,5	—	+ 6,75	7 35 15,69	29,610	—29	Easterly	Hazy, with slight snow	
— 20th	10 A.M.	12	56 28 2,5	—	+ 4,5	7 35 14,63	29,626	—35	Calm	Clear & fine	Thin haze
— 21st	9 A.M.	6	190 55 57,5	—	+ 5,0	7 35 20,00	.....	—40	Calm	Fine weather	near the hor^{n}.
	to	6	325 23 57,5	—	+ 1,0	7 35 18,83	29,460	—	.....	.....	Hazy near the
	1½ P.M.	6	99 52 6,25	—	+ 0,25	7 35 18,50	.....	—36			horizon.
Mar. 4th	10 A.M.	16	238 34 10,25	0,0	+14,50	7 35 20,95	29,600	—31	Calm	Clear & fine	

Mean 7° 35′ 18,32 being the altitude used in Table VIII.

† Micrometrical measure of ∠ between tel. +1 49,82

Apparent altitude of Arcturus at setting by the *lower* tel. 7 37 8,14 being the altitude used in Table IX.

* N.B. The Index was never reset to zero after the observations of the 18th; but the instrument was carefully secured from the weather, without disturbing the verniers, and the succeeding days observations commenced at that part of the arc where the preceding ones left off. The reading, however, of all the verniers was always taken before the commencement of a fresh series of zenith distances; and as no difference in the results of the two days' readings was found, this notice will suffice for all the following observations on the altitude of this board, except that on March 4th, when the principal vernier was set to zero.

† N.B. This measurement between the upper and lower telescopes was obtained after the manner already described, by means of a double wire micrometer attached to one of Dollond's achromatic telescopes of 46 inches focal length, and 3¾ inches aperture. The number and parts of a revolution being in this case $2^{rev.}\ 30^{div.},8$. The value of a revolution, as determined from a series of observations on stars, is 47″,7, from which we deduce 1′ 50″,09 for the angle subtended at the board between the upper and the lower telescopes. But the focal length of the telescope in this measurement being 46,11 in consequence of the distance, instead of 46 inches; the angle thus measured must be reduced in the ratio of these two focal lengths in order to obtain 1′ 49″,82, the correct angular distance between the telescopes.

Table VIII.

Observations for the Atmospheric Refraction observed by the setting of Arcturus, 1824 and 1825. Apparent Altitude 7° 35′ 18″43.

By Lieutenant Foster.

Day.	Time of Arcturus setting by No. 423.	Transit observed. Star.	Transit observed. Time by 423.	Rate of 423.	Arcturus. Horary ∠ at setting.	Arcturus. True altitude.	Observed Refraction.	Barom^{r}. at Temp. +48°.	Temp. Fah^{t}.	Winds (true).	Weather.	Remarks.
1824.	h. m. s.		h. m. s.	s	h. m. s.	° ′ ″	′ ″	Inches.	°			
Nov. 28th	12 54 38	α Andromeda	13 36 52,58	+ 2,8	9 9 20,93	7 27 09,62	8 8,81	29,936	— 5			
Dec. 1st	12 43 02	α Arietis	15 22 52,54	+ 1,72	9 9 24,33	7 26 59,34	8 19,09	30,083	—20	Easterly Fresh	Fine & clear	
2d	12 39 7,5	Ditto	15 18 58,34	+ 2,83	9 9 24,12	7 26 58,21	8 20,22	29,946	—21	..... Light	Hazy	
4th	12 31 20	Ditto	15 11 15,53	+ 4,0	9 9 19,50	7 27 11,94	8 6,49	29,625	—21,8	North	Hazy near the horizon; clear over head.	
5th	12 27 41	α Andromeda	13 9 43,56	+ 3,94	9 9 32,76	7 26 34,84	8 43,59	29,949	—21	Easterly	Very clear	
6th	12 23 44	Ditto	13 5 50,51	+ 3,9	9 9 28,77	7 26 45,65	8 32,78	29,775	—18,8	.....	Sky clear; star twinkled much some time before setting.	
7th	12 19 45	Ditto	13 1 58,45	+ 3,9	9 9 21,77	7 27 04,89	8 13,54	29,522	—11	NNE Fresh	A few fleecy clouds; star clear, did not twinkle this evening.	
8th	12 15 55	Ditto	12 58 06,65	+ 3,6	9 9 23,53	7 26 59,68	8 18,75	29,501	—19,5	NE Light	Sky clear and fine.	
9th	12 12 06	Ditto	12 54 14,86	+ 4,23	9 9 26,31	7 26 51,70	8 26,73	29,725	—18,5	Calm still	Clear even^{g}	
13th	12 10 50,50	Ditto	12 52 54,70	+ 4,0	9 9 30,92	7 26 37,90	8 40,53	30,001	—24,5	North moder.	Sky clear	
	Time by 649.		Time by 649.	Rate, 649.								
14th	12 6 58	Ditto	12 49 04,7	+ 6,4	9 9 28,35	7 26 44,78	8 33,65	30,152	—27,2	WNW		
15th	12 3 10,5	Ditto	12 45 13,63	+ 5,4	9 9 31,84	7 26 34,51	8 43,92	30,336	—35	NE Light		
21st	11 40 05	Ditto	12 22 08,75	+ 6,2	9 9 31,01	7 26 35,60	8 42,83	29,806	—28,2	North	.....	Star bright at setting; Aurora faint S. W.
22d	11 36 12,2	Ditto	12 18 16,96	+ 4,4	9 9 29,90	7 26 38,44	8 39,99	29,877	—29	East	Fine & clear	Aurora faint in the S. W.
23d	11 32 21	Ditto	12 14 25,46	+ 4,2	9 9 30,15	7 26 37,47	8 40,96	29,802	—31	NE	Sky clear	Aurora faint in the S W.
25th	11 24 33,5	Ditto	12 6 40,75	0,0	9 9 27,13	7 26 45,36	8 32,07	29,886	—25,2	Calm	Clear	Aurora faint in the SE. by S.
26th	11 20 41,5	Ditto	12 2 50,33	+ 5,2	9 9 25,68	7 26 49,10	8 29,33	29,983	—27,8	ENE moderate	Sky clear	Star twinkled a little before setting;
28th	11 12 52	Ditto	11 55 7,36	+ 1,3	9 9 18,92	7 27 7,45	8 10,58	29,517	—12,5	East Fresh		[Aurora faint SSW.
29th	11 9 3,50	Ditto	11 51 15,45	+ 2,8	9 9 22,34	7 26 57,60	8 20,83	29,638	—16,5	..... Light	Fine & clear	Star quite bright at the time of observation.
1825.												
Jan. 2d	10 53 44	Ditto	11 35 51,95	+ 5,0	9 9 26,20	7 26 45,18	8 33,25	29,881	—29,4	.....	Clear to the westward, hazy in the eastern quar^{r}.	
3d	10 49 51,50	α Arietis	13 29 41,00	0,0	9 9 23,68	7 26 52,06	8 26,37	29,835	—31,5	.....	Sky clear, with long streaming white clouds	
4th	10 46 00,80	α Andromeda	11 28 9,42	+ 3,8	9 9 25,4	7 26 37,37	8 41,06	29,486	—27,2	ENE Fresh	Sky hazy. A halo round the moon, diameter measuring 23°29′.	
5th	10 42 15,50	Ditto	11 24 17,63	+ 4,3	9 9 31,88	7 26 28,74	8 49,69	29,336	—36,5	Easterly Light	Clear over head and to the west^{wd}; thin slight haze to the	
7th	10 34 26,00	Ditto	11 16 34,10	+ 4,0	9 9 25,80	7 26 45,15	8 33,28	29,509	—35,5	Calm still	Clear even^{g}	[eastward.
10th	10 22 59,50	Ditto	11 5 2,93	+ 5,6	9 9 30,39	7 26 31,73	8 46,70	29,961	—35,5	Easterly Light	Sky clear	
11th	10 19 10,00	Ditto	11 1 11,25	+ 4,0	9 9 32,56	7 26 25,33	8 53,10	30,140	—38,3	.....	.....	Aurora faint to the SSW.
12th	10 15 20,50	Ditto	10 57 20,23	+ 4,9	9 9 34,29	7 26 20,50	8 57,93	29,953	—38,5	.....	.....	
15th	10 03 43,50	Ditto	10 45 45,85	+ 4,5	9 9 31,21	7 26 28,53	8 49,90	29,711	—27,5	.....	.....	Aurora faint to the southward.
16th	9 59 49,00	Ditto	10 41 55,78	+ 6,2	9 9 26,78	7 26 40,64	8 37,79	29,730	—31,5	.... moderate	.....	
17th	9 55 58,00	Ditto	10 38 4,91	+ 5,07	9 9 26,58	7 26 41,00	8 37,43	29,638	—28	.....	Slight^{y} hazy	
20th	9 44 21,00	α Pegasi	9 23 24,07	+ 5,4	9 9 21,55	7 26 54,42	8 24,01	29,409	—26,2	NE Light	Sky clear	
22d	9 36 35,00	α Andromeda α Pegasi	10 18 51,20 9 15 43,05	+ 5,84	9 9 16,77	7 27 7,39	8 11,04	29,341	—25,5	NNE Fresh	Sky hazy, through which the star was indistinctly seen at setting.	
24th	9 29 12,00	α Pegasi α Andromeda	9 8 2,18 10 11 9,56	+ 3,87	9 9 35,02	7 26 16,21	9 2,22	29,820	—37,2	..... Light	Sky clear, except a few light clouds to the eastward, and low down southwward.	
25th	9 25 15,00	α Pegasi	9 4 11,47	+ 5,5	9 9 27,98	7 26 35,77	8 42,66	29,795	—42,2	NE	Sky clear	
27th	9 17 28,50	Ditto	8 56 30,00	+ 6,2	9 9 22,85	7 26 49,70	8 28,73	29,847	—27	NWb N Fresh	.....	Star bright and clear at setting.
Feb. 2d	8 54 25,50	α Andromeda	9 36 29,55	+ 3,84	9 9 28,74	7 26 32,54	8 45,89	30,139	—40,9	East moderate	.....	
10th	8 23 26,50	Ditto	9 05 32,53	+ 4,00	9 9 26,47	7 26 38,02	8 40,41	30,211	—37	Calm	.....	
						Means	8 36,36	29,805	—27,3			

Table IX.

Observations for the Atmospheric Refraction observed by the setting of Arcturus, 1824 and 1825. Apparent Altitude 7° 37′ 8″,14.

By Lieutenant Foster.

Days.	Time of Arcturus setting by No. 649.	Transit observed.		Rate of 649.	Arcturus.		Observed Refraction.	Barom^{r}. at Temp. + 48°	Temp Faht.	Winds (true).	Weather.	Remarks.
		Star.	Time by No. 649.		Hor ∠ at setting.	True altitude.						
1824.	h. m. s.		h. m. s.	s	h. m. s.	° ′ ″	′ ″	Inches.	°			
Dec. 21st	11 39 19	α Andromeda	12 22 08,75	+6,2	9 8 44,91	7 28 43,83	8 24,31	29,806	—28,2	North Light	Sky clear	Star bright at setting; Aurora faint in the SW.
22d	11 35 35,5	Ditto	12 18 16,96	+4,4	9 8 53,1	7 28 20,76	8 47,38	29,877	—29	East	Fine & clear	Aurora faint in the SW.
23d	11 31 42,5	Ditto	12 14 25,46	+4,2	9 8 51,50	7 28 24,94	8 43,20	29,802	—31	NE	Sky clear	Aurora faint in the SW; star bright.
25th	11 23 56	Ditto	12 06 40,75	0,0	9 8 49,53	7 28 29,92	8 38,22	29,886	—25,2	Calm	Clear	Aurora faint in the SE b S.
26th	11 20 01	Ditto	12 02 50,33	+5,2	9 8 45,07	7 28 42,10	8 26,04	29,989	—27,8	ENE moderate	Sky clear	Aurora faint in the SSW; star twinkled a little before setting.
1825.												
Jan. 2d	10 53 03,2	Ditto	11 35 51,95	+5,0	9 8 45,29	7 28 38,98	8 29,16	29,881	—29,4	East Light	Clear to the westw^{d}, hazy in the eastern quarter.	
3d	10 49 11,5	α Arietis	13 29 41	0.0	9 8 43,57	7 28 43,75	8 24,39	29,835	—31,5	.....	Sky clear, with long streaming white clouds.	
5th	10 41 34,5	α Andromeda	11 24 17,63	+4,3	9 8 50,77	7 28 23,04	8 45,10	29,336	—36,5	.....	Clear over head and to the westward, thin slight haze to the eastward	
7th	10 33 49,2	Ditto	11 16 34,10	+4,0	9 8 48,90	7 28 28,56	8 39,58	29,509	—35,5	Calm	Still clear evens	
10th	10 22 19	Ditto	11 05 02,93	+5 6	9 8 49,78	7 28 24,88	8 43,26	29,961	—35,5	Easterly Light	Sky clear	
11th	10 18 34	Ditto	11 1 11,25	+4,0	9 8 56,46	7 28 05,68	8 52,46	30,140	—38,3	.....	.....	Aurora faint to the SSW.
12th	10 14 38,5	Ditto	10 57 20,23	+4,9	9 8 52,17	7 28 17,62	8 50,51	29,953	—38,5	.....	.....	
15th	10 03 00	Ditto	10 45 45,85	+4,5	9 8 47,59	7 28 29,82	8 38,32	29,711	—27,5	.....	.....	Aurora faint to the southward.
16th	9 59 09	Ditto	10 41 55,78	+6,2	9 8 46,67	7 28 32,18	8 35,96	29,730	—31,5	.... moderate	.....	
17th	9 55 17	Ditto	10 38 04,91	+5,07	9 8 45,47	7 28 35,35	8 32,79	29,638	—28	.....	Slightly hazy	
20th	9 43 40,8	α Pegasi	9 23 24,07	+5,4	9 8 41,24	7 28 46,57	8 21,57	29,409	—26,2	NE Light	Sky clear	
22d	9 35 57	α Pegasi α Andromeda	9 15 43,05 10 18 51,2	+5,84	9 8 38,67	7 28 53,44	8 14,70	29,341	—25,5	NNE Fresh	Sky hazy, through which the star was indistinctly seen at setting.	
24th	9 28 32	α Pegasi α Andromeda	9 08 02,18 10 11 9,56	+3,87	9 8 54,91	7 28 07,88	9 00,26	29,820	—37,2	.... Light	Sky clear, except a few light clouds to the eastward, and low down southward.	
25th	9 24 37,8	α Pegasi	9 4 11,47	+5,5	9 8 50,68	7 28 19,51	8 48,63	29,795	—42,2	NE	Sky clear	
27th	9 16 49,5	Ditto	8 56 30	+6,2	9 8 43,75	7 28 38,49	8 29,65	29,847	—27	NWbN Fresh	.....	Star bright and clear at setting.
Feb. 2d	8 53 48	α Andromeda	9 36 29,55	+3,84	9 8 51,14	7 28 17,09	8 51,05	30,139	—40,9	East moderate	.....	
						Means	8 35,07	29,786	—32,0			

Table X.

Observations for determining the Apparent Altitude of α Aquilæ at the time of setting, by Lieutenant Foster's *upper* telescope.

The corresponding Observations for Refraction are contained in Tables XI. and XII.

Day.	Time.	No. of Observations.	Mean reading of four Verniers.	Correction for Index	Correction for Level.	Apparent zenith distance.	Apparent altitude deduced from the apparent zenith distance by the ratio of the No. of observations.	Baromr. at Temp. + 48°.	Temp. Faht.	Winds True.	Remarks.
1825.	h. m.		° ′ ″	″	″	° ′ ″	° ′ ″	Inches.	°		
Jan. 28th	At 11 A.M.	8	323 7 57,5	0,0	+1,0	85 23 29,81	4 36 25,97	29,970	— 29,5	.....	Occasionally squally
——	1 30 P.M.	14	* 78 38 30,0	—	+8,25	85 23 37,20					
Feb. 7th	— 11 A.M.	8	323 8 20,0	0,0	—0,5	85 23 32,44	4 36 22,17	29,455	— 22,5	North mod.	
——	2 P.M.	8	*286 18 5,0	—	+0,75	85 23 43,22					
9th	— 10 A.M.	8	323 8 1,25	0,0	+3,0	85 23 30,53	4 36 21,67	29,701	— 35,7	Calm	Fine
——	1 P.M.	14	*115 32 16,25	—	+2,25	S5 23 44,18				Fine & clear	
— 10th	— 10 30 A.M.	6	*152 21 51,25	—	+3,25	85 23 39,08	4 36 21,46	30,100	— 35,5	Calm	
——	1 30 P.M.	6	*304 43 41,25	—	—2,0	85 23 38,00					
— 15th	— 11 A.M.	12	*304 43 8,75	—	+2,50	85 23 35,94	4 36 24,06	29,600	— 33	Cloudy, overcast weather.	
— 28th	— 11 A,M.	6	*152 22 1,25	—	—3,50	85 23 39,62	4 36 23,13	29,992	— 21	NE Light	Clear & fine
——	1 30 P.M.	6	*304 43 25,00	—	+1,00	85 23 34,12					

Mean = the apparent altitude, *upper* telescope 4 36 13,08, being the altitude used in Table XI.

† Micrometrical measure of ∠ subtended at the board between the telescopes = + 3 8,42

Apparent altitude for the *lower* telescope 4 39 31,50, being the altitude used in Table XII.

• The principal vernier not reset to zero, and the observations are continued from the preceding reading.

† The number and parts of a revolution in this case being $3^{rev.}\ 96^{div.},7$, we obtain 3′ 9″,22 for the angular distance between the telescopes used in the observations on refractions. The focal length, however, of the telescope to which the micrometer was attached being in the present case 46,19, instead of 46 as before stated, and the above angular distance being reduced in the ratio of 46,19 to 46, we have 3′ 8″,42 for the correct angle subtended by the distance between the upper and lower telescopes.

Table XI.

Observations for the Atmospheric Refraction, observed by the setting of α Aquilæ, 1824 and 1825. Apparent Altitude 4° 36′ 32″,08. By Lieutenant Foster.

Day.	Time of α Aquilæ setting by No. 423.	Transit Observed. Star.	Transit Observed. Time by No. 423.	Rate of 423.	α Aquilæ. Horary ∠ at setting.	α Aquilæ. True Altitude.	Observed Refraction.	Barom. at Temp. +48°,	Temp. Fahᵗ.	Winds (true.)	Weather.	Remarks.
1824.	h. m. s.		h. m. s.	s.	h. m. s.	° ′ ″	′ ″	Inches.	°			
Dec 8th	3 31 58	α Arietes.	2 55 46,28	+ 3,6	6 51 24,69	4 22 58,87	13 24,21	29,544	—18	NNE Squally	Sky Clear	
	Time by 649		Time by 649	Rate 649								
11th	3 34 26	Ditto	2 58 16,40	+ 4,9	6 51 32,55	4 23 07,45	13 15,63	29,708	—14	NNW Fresh	Clear and Fine	
13th	3 26 59,50	Ditto	2 50 34,03	+ 4,0	6 51 38,45	4 22 42,51	13 40,57	30,057	—25	North Light	Ditto	
14th	3 23 03	Ditto	2 46 45,13	+ 6,4	6 51 30,77	4 23 14,99	13 08,09	30,190	—18,5	West Ditto	Sky Clear	Star indistinctly seen at setting.
16th	3 15 24	Aldebaran	5 07 12,99	+ 5,7	6 51 34,38	4 22 59,17	13 23,91	30,098	—35	ENE Ditto	Ditto	Aurora faint to the SW. Some streamers
20th	2 59 58	α Arietis	2 23 38.26	+ 5,0	6 51 32,65	4 23 05,73	13 17,35	29,666	—26,3	North Ditto	Clear still evenᵍ.	Aurora faint to the SW. [NW.
21st	2 56 02,20	Ditto	2 19 48,27	+ 6,2	6 51 26,79	4 23 32,61	12 50,47	29,794	—26,8	SW Fresh	Sky Clear	Aurora bright to the SW.
22d	2 52 15	Ditto	2 15 56,88	+ 4,4	6 51 25,04	4 23 37,40	12 45,68	29,844	—27,2	SW Light	Sky Clear & fine	Aurora faint to the SW.
23d	2 48 24,50	Ditto	2 12 4,76	+ 4,2	6 51 26,66	4 23 30,48	12 52,60	29,810	—32	Calm	Fine Clear evenᵍ.	Aurora SW.
25th	2 40 32,00	Ditto	2 4 20,26	0,0	6 51 24,71	4 23 38,35	12 44,73	29,929	—26	NNE Light	Sky Clear	Aurora faint to the westward.
26th	2 36 43	Ditto	2 00 29,36	+ 5,2	6 51 26,46	4 23 30,87	12 52,21	29,988	—26,5	ENE Moderate	Sky Clear over head,	thin light clouds near the horizon, through which the star was faintly seen at setting.
29th	2 25 01	Ditto	1 48 55,13	+ 4,1	6 51 18,67	4 24 03,14	12 19,94	29,666	—16	Eastward Light	Fine and Clear	Thin haze near the horizon, but through which, the stars were distinctly seen.
1825.												
Jan. 1st	2 13 36,50	α Ceti	2 33 03,82	+ 5,2	6 51 25,34	4 23 33,73	12 49,35	29,836	—26	Ditto Ditto	Sky Clear	Star bright at setting.
2d	2 9 48,40	α Arietis	1 33 32,33	+ 4,6	6 51 28,78	4 23 19.03	13 04,05	29,847	—30	Ditto Ditto	Thin white clouds to the SW.	Star set very bright.
3d	2 5 56,50	Ditto	1 29 41,00	— 2,9	6 51 28,28	4 23 21,04	13 02,04	29,828	—33	Ditto Mod.	Sky Clear	Star bright at setting. [parts.
5th	1 58 12,80	Ditto	1 21 56,76	+ 4,3	6 51 28,71	4 23 18.93	13 04,15	29 356	—35,5	Ditto Light	Thin haze to the eastward, perfectly clear in other	
6th	1 57 17,50	Ditto	1 18 5,36	+ 4,55	6 51 24,81	4 23 35,10	12 47,98	29,322	—32,2	North Ditto	Hazy	Star distinctly seen at setting.
10th	1 39 2,00	Ditto	1 2 42,78	+ 5,6	6 51 32,77	4 23 01,21	13 21,87	30 050	—35,5	Easterly Ditto	Clear	
11th	1 35 16,00	Ditto	0 58 50,31	+ 4,0	6 51 38,27	4 22 38,03	13 45,05	30 125	—39,3	Ditto Ditto	Sky Clear	Aurora faint to the SSW.
12th	1 31 21,00	Ditto	0 54 59,36	+ 4,9	6 51 34,16	4 22 55,11	13 27,97	29 984	—38,7	Ditto Ditto	Ditto	Stars very bright.
15th	1 19 42,80	Ditto	0 43 25,66	+ 4,5	6 51 28,60	4 23 18,14	13 04,94	29,732	—28	Ditto Ditto	Clear and Fine	Aurora faint to the southᵈ. Stars somewhat obscured at setting.
16th	1 15 53,80	Ditto	0 39 36,36	+ 6,2	6 51 29,82	4 23 12,70	13 10,38	29,754	—32,8	Ditto Mod.	Sky Clear	Stars bright. Aurora faint in S W near horizon.
17th	1 12 03,20	Ditto	0 35 45,56	+ 5,07	6 51 30,03	4 23 11,67	13 11,41	29,622	—26,5	Ditto Fresh	Somewhat Hazy	Aurora faint low down to the WSW.
18th	1 08 06,80	Ditto	0 31 53,48	+ 4,1	6 51 25,71	4 23 29,38	12 53,70	29,561	—23	NE Strong	Sky Clear	Aurora faint SW. Star somewhat indistinct at setting in consequence of drift.
20th	1 00 24,50	Ditto	0 24 12,47	+ 5,4	6 51 27,34	4 23 22,51	13 00,57	29,372	—29	North Light	Ditto	Aurora faint near horizon to the southwᵈ.
25th	0 41 22,50	Ditto	0 05 00,32	+ 5,5	6 51 34,37	4 22 52,36	13 30,72	29,787	—43,2	Easterly Ditto	Ditto	A few thin clouds to the S. about the moon
27th	12 33 44,50	Ditto	11 57 19,53	+ 6,2	6 51 37,12	4 22 40,56	13 42,52	29,836	—28	NW Fresh	Ditto	Star bright at setting.
Feb. 2d	12 10 35,00	Ditto	11 34 10,08	+ 3,84	6 51 36,92	4 22 40,58	13 42,50	30,229	—41,5	East Light	Ditto	
4th	12 02 36,50	α Arietis α Cetis	11 26 23,40 12 22 03,68	+ 2,91	6 51 24,91	4 23 30,61	12 52,47	30,056	—19,5	ENE Strong and squally, sky clear over head, considerable drift, but the star bright at setting.		
7th	11 59 59,50	α Arietis α Ceti	11 14 47,94 12 10 28,17	+ 4,1	6 51 23,22	4 23 37,31	12 45,77	29,583	—26,5	Calm, Clear and very fine.		Faint twilight to the westward.
8th	11 47 21,80	α Androm. α Ceti	9 13 16,55 12 06 36,50	+ 4,33	6 51 37,05	4 22 39,29	13 43,79	29,745	—37	Calm Clear still evening.		
9th	11 43 25,20	α Arietis α Ceti	11 07 04,25 12 2 44,95	+ 4,41	6 51 32,11	4 22 59,85	13 23,23	29,959	—37,6	Eastward Light	Sky perfectly clear.	
						Means	13 09,37	29,808	—29,0			

Table XII.

Observations for the Atmospheric Refraction, observed by the setting of α Aquilæ, 1824 and 1825. Apparent Altitude 4° 39′ 31″,50.
By Lieutenant Foster.

Days.	Time of α Aquilæ setting by No. 649.	Transit observed. Star.	Transit observed. Time by 649.	Rate of 649.	α Aquilæ. Hor. ∠ at setting.	α Aquilæ. True altitude.	Observed Refraction.	Barom. at Temp. + 48°.	Temp. Fahᵗ.	Winds (true).	Weather.	Remarks, &c.
1824.	h. m. s.		h. m. s.	s.	h. m. s.	° ′ ″	′ ″	Inches.	°			
Dec. 20th	2 59 11	α Arietis	2 23 38,26	+5,0	6 50 45,52	4 26 23,13	13 8,37	29,666	—26,3	Clear still evening		Aurora faint to the SW.
21st	2 55 15	Ditto	2 19 48,27	+6,2	6 50 39,49	4 26 48,2	12 43,3	29,794	—26,8	North Fresh	Sky clear	Aurora bright to the SW.
25th	2 39 49,5	Ditto	2 4 20,26	0,0	6 50 42,09	4 26 36,69	12 54,81	29,929	—26	NNE Light	.....	Aurora faint to the westward.
29th	2 24 16	Ditto	1 48 55,13	+4,1	6 50 33,51	4 27 12,28	12 19,52	29,666	—16	Eastward	Fine & clear	Thin haze near the horizon, through which the stars were distinctly seen.
1825.												
Jan. 1st	2 12 51,5	α Ceti	2 33 03,82	+5,2	6 50 40,22	4 26 42,82	12 48,68	29,836	—26	.....	Sky clear	Star bright at setting.
2d	2 09 00	α Arietis	1 33 32,33	+4,6	6 50 40,25	4 26 42,7	12 48,80	29,847	—30	.....	Thin white clouds to the SW; star set very bright.	
3d	2 05 09	Ditto	1 29 41,00	—2,9	6 50 40,65	4 26 40,55	12 50,95	29,828	—33	.... moderate	Sky clear; star bright at setting.	
5th	1 57 26	Ditto	1 21 56,76	+4,3	6 50 41,78	4 26 35,74	12 55,76	29,356	—35,5	.... Light	Thin haze to the eastward, perfectly clear in other parts.	
6th	1 53 33,5	Ditto	1 18 05,36	+4,55	6 50 40,69	4 26 39,91	12 51,59	29,322	—32,2	North	Hazy	Star distinctly seen at setting.
10th	1 38 19	Ditto	1 02 42,78	+5,6	6 50 49,65	4 26 01,8	13 29,70	30,050	—35,5	Easterly	Clear	
11th	1 34 29,7	Ditto	0 58 50,31	+4,0	6 50 51,84	4 25 52,11	13 39,39	30,125	—39,3	.....	Sky clear	Aurora faint to the SSW.
12th	1 30 35	Ditto	0 54 59,36	+4,9	6 50 48,03	4 26 8,35	13 23,15	29,984	—38,7	.....	.....	Star bright.
15th	1 18 58,5	Ditto	0 43 25,66	+4,5	6 50 44,18	4 26 23,96	13 7,54	29,732	—28	.....	Clear & fine	Aurora faint to the southward, star somewhat obscured at setting.
16th	1 15 07,5	Ditto	0 39 36,36	+6,2	6 50 42,39	4 26 31,35	13 00,15	29,754	—32,8	.... moderate	Sky clear	Stars bright; Aurora faint in the SW near horizon.
17th	1 11 16,8	Ditto	0 35 45,56	+5,07	6 50 43,50	4 26 30,25	13 1,25	29,622	—26,5	.... Fresh	Somewhat hazy	Aurora faint near horizon to the WSW.
20th	0 59 39,5	Ditto	0 24 12,47	+5,4	6 50 42,22	4 26 31,6	12 59,90	29,372	—29	Northw. light	Sky clear	Aurora faint near horizon to the southward.
25th	0 40 38,4	Ditto	0 05 00,32	+5,5	6 50 50,15	4 25 57,55	13 33,95	29,787	—43,2	Easterly	.....	A few thin clouds to the southward about the moon.
27th	0 32 54,2	Ditto	11 57 19,53	+6,2	6 50 46,68	4 26 11,79	13 19,71	29,836	—28	NW Fresh	.....	Star bright at setting.
Feb. 2d	12 09 47,8	Ditto	11 34 10,08	+3,84	6 50 49,59	4 25 58,75	13 32,75	30,229	—41,5	Easterly Light		
4th	12 01 53,5	α Arietis α Ceti	11 26 23,4 12 22 3,68	+2,91	6 50 41,79	4 26 31,22	13 00,28	30,056	—19,5	ENE strong and squally. Sky clear over head, considerable drift; star bright at setting.		
7th	11 50 10,9	α Arietis α Ceti	11 14 47,94 12 10 28,17	+4,1	6 50 34,49	4 27 01,45	12 30,05	29,583	—26,5	Calm, clear and very fine; faint twilight to the westward.		
8th	11 46 32,8	α Andromeda α Ceti	9 13 16,55 12 6 36,5	+4,33	6 50 47,92	4 26 05,03	13 26,47	29,745	—37	Calm, clear still evening.		
9th	11 42 40,2	α Arietis α Ceti	11 7 04,25 12 2 44,95	+4,41	6 50 46,99	4 26 8,81	13 22,69	29,959	—37,6	Eastward Light; sky perfectly clear.		
						Means	13. 4,73	29,742	—31,1			

Table XIII.

Observations for the Atmospheric Refraction observed by the setting of Arcturus, 1824-25. Apparent Altitude 7° 38′ 0,″52. By Lieutenant Ross.

Date.	Time of Arcturus setting reduced to 649.	Transit Observed. Star.	Transit Observed. Time by 649.	Rate of 649 Gaining.	Arcturus's Horary ∠ at setting.	Arcturus's True Altitude.	Observed Refraction.	Barom. at Temp. + 50°.	Temp. Fah^{t}.	Winds True.	Weather.	Remarks.
1824.	h. m. s.		h. m. s.	s.	h. m. s.	° ′ ″	′ ″	Inches.	°			
Dec. 15th	12 02 10,8	α Andromedæ	12 45 13,63	5,4	9 8 31,98	7 29 21,2	8 39,51	30,334	—35	NE^{y} Light	Very Clear	
21st	11 38 58	Ditto	12 22 8,75	6,2	9 8 23,95	7 29 41,79	8 18,93	29,819	—28,2	North Ditto	Ditto	Aurora SW to S faint.
26th	11 19 34	Ditto	12 02 50,33	5,22	9 8 18,01	7 29 57,17	8 3,55	29,984	—27,8	ENE Moderate	Ditto	Aurora SSW faint.
1825.												
Jan. 4th	10 44 59	Ditto	11 28 9,42	3,8	9 8 23,44	7 29 38,67	8 21,85	29,485	—27,2	Ditto Squally	Hazy near hori^{n}.	Star very distinct.
5th	10 41 05,5	Ditto	11 24 17,63	4,30	9 8 21,68	7 29 43,66	8 16,86	29,345	—36,5	East Light	Ditto	Star clear.
6th	10 37 14,7	Ditto	11 20 26,2	4,55	9 8 22,27	7 29 41,58	8 18,94	29,263	—32,2	Ditto Ditto	Ditto	Ditto.
7th	10 33 23,7	Ditto	11 16 34,1	4,0	9 8 23,32	7 29 38,46	8 22,06	29,525	—35,5	Ditto Ditto	Very Clear	
10th	10 21 53	Ditto	11 5 2,93	5,6	9 8 23,71	7 29 36,88	8 23,64	29,955	—35,5	Ditto Ditto	Ditto	
11th	10 18 11	Ditto	11 1 11,25	4,0	9 8 33,32	7 29 10,19	8 50,33	30,136	—38,3	Ditto Ditto	Ditto	
12th	10 14 13	Ditto	10 57 20,23	4,9	9 8 26,29	7 29 29,52	8 31,0	29,946	—38,4	Ditto Ditto	Ditto	
15th	10 2 34,5	Ditto	10 45 45,85	4,5	9 8 22,01	7 29 26,61	8 33,91	29,708	—27,5	Ditto Ditto	Ditto	Faint twilight west. [horizon.
16th	9 58 43,5	Ditto	10 41 55,78	6,2	9 8 21,10	7 29 43,04	8 17,48	29,730	—31,2	East Moderate	Ditto	Aurora faint SSW near
17th	9 54 52,7	Ditto	10 38 4,91	5,07	9 8 21,07	7 29 42,83	8 17,69	29,638	—28	Ditto Ditto	{ Some light Clouds }	Star twinkling.
20th	9 43 16	α Pegasi	9 23 24,07	5,4	9 8 16,35	7 29 56,4	8 4,12	29,404	—26,2	North Ditto	Clear	Twilight strong,
24th	9 28 03	α Andromedæ	10 11 9,56	3,87	9 8 26,46	7 29 26,61	8 33,91	29,822	—37,2	NE Light	Ditto	
25th	9 24 10	α Pegasi	9 4 11,47	5,5	9 8 22,78	7 29 36,8	8 23,72	29,793	—42,2	Ditto Ditto	Very Clear	
27th	9 16 26	Ditto	8 56 30	6,2	9 8 20,17	7 29 43,87	8 16,65	29,846	—27	NW Fresh	Clear with drift	Star clear.
						Mean	8 23,18	29,749	—32,6			

Table XIV.

Observations for the Atmospheric Refraction observed by the setting of α Aquilæ, 1825. Apparent Altitude 4° 37′ 41,″08.
By Lieutenant Ross.

Date.	Time of α Aquilæ's setting reduced to 649.	Transit Observed. Star.	Transit Observed. Time by No. 649.	Rate of No. 649. gaining	α Aquilæ's Horary ∠ at setting.	α Aquilæ's True Altitude.	Observed Refraction.	Barom. at Temp. + 50°.	Temp. Fah^{t}.	Winds True.	Weather.	Remarks.
1825.	h. m. s.		h. m. s.	s.	h. m. s.	° ′ ″	′ ″	Inches.	°			
Jan. 5th	13 57 50,3	α Arietis	13 21 56,76	4,3	6 51 06,10	4 24 52,75	12 48,33	29,356	—35,7	East Light	Clear	
6th	13 53 59,5	Ditto	13 18 05,36	4,55	6 51 06,72	4 24 51,1	12 49,98	29,322	—32,2			
7th	13 50 09,1	Ditto	13 14 13,44	4,00	6 51 08,25	4 24 44,29	12 56,79	29,557	—36	.....	Very Clear	
10th	13 38 41,5	Ditto	13 02 42,78	5,60	6 51 11,28	4 24 30,02	13 11,06	30,054	—35,5	.....	.....	
11th	13 34 53,7	Ditto	12 58 50,31	4,0	6 51 15,93	4 24 10,56	13 30,52	30,127	—39,3	.....	.....	
12th	13 30 58,5	Ditto	12 54 59,36	4,9	6 51 11,58	4 24 29,67	13 11,41	29,983	—38,7	.....	.....	
15th	13 19 24	Ditto	12 43 25,66	4,5	6 51 10,74	4 24 34,99	13 06,09	29,737	—28	.....	.....	Star rather dim at setting.
16th	13 15 31	Ditto	12 39 36,36	6,2	6 51 06,95	4 24 49,07	12 52,01	29,759	—32,8	SW Moderate	[drift.	
17th	13 11 40,3	Ditto	12 35 45,56	5,07	6 51 07,46	4 24 46,79	12 54,29	29,623	—26,5	East Fresh	Squally with snow	Hazy near the horizon.
20th	13 00 04,8	Ditto	12 24 12,47	5,40	6 51 04,56	4 24 57,31	12 43,77	29,372	—29	North Light	Very Clear	
						Mean	13 00,42	29,689	—33,37			

Table XV.

Observations for the Atmospheric Refraction observed by the setting of α Aquilæ, 1824-25. Apparent Altitude 4° 36′ 3,″88.
By Lieutenant Ross.

Date.	Time of α Aquilæ's setting reduced to 649.	Transit Observed. Star.	Transit Observed. Time by No. 649.	Rate of No. 649. gaining.	α Aquilæ's Horary ∠ at setting.	α Aquilæ's True Altitude.	Observed Refraction.	Barom. at Temp. + 50°.	Temp. Fah^{t}.	Winds True.	Weather.	Remark.
1824.	h. m. s.		h. m. s.	s.	h. m. s.	° ′ ″	′ ″	Inches.	°			
Dec. 26th	14 36 43,7	α Arietis	14 00 29,36	5,2	6 51 27,16	4 23 27,74	12 36,14	29,987	—26,5	East Fresh		Star dim at time of setting.
29th	14 25 05,8	Ditto	13 48 55,13	4,10	6 51 23,47	4 23 43,69	12 20,19	29,666	—16	Ditto Light	Fine Clear	
1825.												
Jan. 5th	13 58 16,3	Ditto	13 21 56,76	4,30	6 51 32,16	4 23 05,18	12 58,70	29,356	—35,7	.....	.....	
6th	13 54 24,3	Ditto	13 18 05,36	4,55	6 51 31,6	4 23 07,25	12 56,63	29,322	—32,2	.....	Clear overhead	Hazy near horizon.
7th	13 50 32,5	Ditto	13 14 13,44	4,00	6 51 31,72	4 23 07	12 56,88	29,557	—36	.....	Very Clear	
10th	13 39 05,2	Ditto	13 02 42,78	5,60	6 51 35,04	4 22 51,72	13 12,16	30,054	—35,5	.....	.....	
11th	13 35 18	Ditto	12 58 50,31	4,00	6 51 40,29	4 22 29	13 34,88	30,127	—39,3	.....	.....	
12th	13 31 23,5	Ditto	12 54 59,36	4,90	6 51 36,65	4 22 44,72	13 19,16	29,983	—38,7	.....	.....	
15th	13 19 49	Ditto	12 43 25,66	4,50	6 51 35,79	4 22 47,81	13 16,07	29,737	—28	.....	.....	
16th	13 15 55,5	Ditto	12 39 36,36	6,2	6 51 31,52	4 23 06,42	12 57,46	29,759	—32,8	SW Moderate	.....	Star dim at setting.
17th	13 12 03,8	Ditto	12 35 45,56	5,07	6 51 30,62	4 23 09,73	12 54,15	29,623	—26,5	East Fresh	Squally with snow drift.	
20th	13 00 28	Ditto	12 24 12,47	5,4	6 51 27,83	4 23 20,08	12 43,80	29,372	—29	North Light	Very Clear	
						Mean	12 58,85	29,712	31,35			

Table XVI.

Observations for the Atmospheric Refraction observed by the setting of α Aquilæ, 1825. Apparent Altitude 4° 40′ 38″.
By Lieutenant Ross.

Date.	Time of α Aquilæ's setting reduced to 649.	Transit observed. Star.	Transit observed. Time by 649.	Rate of 649. Gaining.	α Aquilæ's Horary ∠ at setting.	α Aquilæ's True altitude.	Observed Refraction.	Barometer at Temp. + 50°.	Temp. Fah^{t}.	Winds True.	Weather.	Rem arks.
1825.	h. m. s.		h. m. s.	s.	h. m. s.	° ′ ″	′ ″	Inches.	°			
Jan. 5th	13 57 06,3	α Arietis	13 21 56,76	4,3	6 50 22,02	4 27 57,1	12 40,9	29,356	—35,7	East Light	Clear	[westward.
6th	13 53 15,8	Ditto	13 18 05,36	4,55	6 50 22,90	4 27 54,0	12 44	29,322	—32,2	.....	.....	Hazy, near horizon to the
7th	13 49 25,5	Ditto	13 14 13,44	4,0	6 50 24·53	4 27 47,0	12 51	29,557	—36	.....	Very clear	Aurora SW.
10th	13 37 57,5	Ditto	13 02 42,78	5,6	6 50 27,15	4 27 36,44	13 01,56	30,054	—35,5	.....	.....	
11th	13 34 11	Ditto	12 58 50,31	4,0	6 50 33,10	4 27 10,97	13 27,03	30,127	—39,3	.....	.....	
12th	13 30 13,8	Ditto	12 54 59,36	4,9	6 50 26,76	4 27 38,09	12 59,91	29,983	—38,7	.....	.....	
15th	13 18 39,5	Ditto	12 43 25,66	4,5	6 50 26,13	4 27 40,17	12 57,83	29,737	—28	.....	.....	Star rather dim at setting.
16th	13 14 46,7	Ditto	12 39 36,36	6,2	6 50 22,53	4 27 54,2	12 43,8	29,759	—32,8	SW moderate	.....	
17th	13 10 56,3	Ditto	12 35 45,56	5,07	6 50 22,95	4 27 52,13	12 45,87	29,623	—26,5	East Fresh	Clear	Squally with snow drift.
20th	12 59 21,3	Ditto	12 24 12,47	5,4	6 50 20,94	4 28 00,0	12 38,0	29,372	—29	North Light	Very clear	
						Means	12 48,17	29,785	—33,37			

Table XVII.

Observations for the Atmospheric Refraction observed by the setting of α Aquilæ, 1824-25. Apparent Altitude 4° 39′ 01″,8.
By Lieutenant Ross.

Date.	Time of α Aquilæ's setting reduced to 649.	Transit observed. Star.	Transit observed. Time by 649.	Rate of 649. Gaining.	α Aquilæ's Horary ∠ at setting.	α Aquilæ's True altitude.	Observed Refraction.	Barometer at Temp. + 50°.	Temp. Fah^{t}.	Winds True.	Weather.	Remarks.
1824.	h. m. s.		h. m. s.	s.	h. m. s.	° ′ ″	′ ″	Inches.	°			
Dec. 14th	15 22 21,2	α Arietis	14 46 45,13	6,4	6 50 46,90	4 26 18,0	12 43,8	30,189	—28,2	WNW Light	Clear	
20th	14 59 13,6	Ditto	14 23 38,26	5,0	6 50 48,12	4 26 11,6	12 50,2	29,674	—26,3	North .. .	.....	
23d	14 47 39,5	Ditto	14 12 04,76	4,2	6 50 47,49	4 26 14,7	12 47,1	29,810	—32	Calm	.....	
26th	14 35 59,5	Ditto	14 00 29,36	5,2	6 50 42,83	4 26 34,35	12 26,45	29,987	—26,5	East Fresh	.....	
29th	14 24 20,6	Ditto	13 48 55,13	4,1	6 50 38,13	4 26 52,55	12 09,25	29,666	—16	.... Light	.....	Star dim at time of setting.
1825.												
Jan. 5th	13 57 31,5	Ditto	13 21 56,76	4,3	6 50 47,28	4 26 12,42	12 49,38	29,356	—35,7	.....	.....	
6th	13 53 40,3	Ditto	13 18 05,36	4,55	6 50 47,47	4 26 11,39	12 50,41	29,322	—32,2	.....	Clear overhead, hazy near horizon.	
7th	13 49 49,8	Ditto	13 14 13,44	4,0	6 50 48,9	4 26 05,18	12 56,62	29,557	—36	.....	Very clear	
10th	13 38 21	Ditto	13 02 42,78	5,6	6 50 50,71	4 25 55,86	13 05,94	30,054	—35,5	.....	.....	
11th	13 34 35	Ditto	12 58 50,31	4,0	6 50 57,17	4 25 30,64	13 31,16	30,127	—39,3	.....	.....	
12th	13 30 38	Ditto	12 54 59,36	4,9	6 50 51,03	4 25 54,82	13 06,98	29,983	—38,7	.....	.....	
15th	13 19 03	Ditto	12 43 25,66	4,5	6 50 49,68	4 25 59,59	13 12,21	29,737	—28	.....	.....	Star rather dim at setting.
16th	13 15 11,5	Ditto	12 39 36,36	6,2	6 50 47,39	4 26 10,35	12 56,45	29,759	—32,8	SW moderate	.....	
17th	13 11 19,5	Ditto	12 35 45,56	5,07	6 50 46,21	4 26 11,81	12 50,0	29,623	—26,5	East Fresh	Squally with snow drift, hazy near horiz.	
20th	12 59 43,8	Ditto	12 24 12,47	5,4	6 50 43,50	4 26 26,71	12 35,09	29,372	—29	North Light	Very clear.	
						Means	12 51,4	29,748	—30,85			

On looking over each individual's observations, it will be seen, that great changes in the amount of atmospherical refraction took place, without any correspondent change in the state of either the barometer or thermometer; and, although the mode of observation adopted by us, is not wholly free from objection, inasmuch, as the ray of light from a bright star may suffer some degree of inflection, by passing over a sharp edge (such as the boards placed edge-wise would present, whereby their apparent altitudes would not be exactly those of the stars at the time of observation); yet we do not consider this circumstance the cause of the anomaly alluded to, for we never entertained the slightest doubt as to the moment of either of the stars' disappearance, both being always instantaneous: and, moreover, when it is recollected, that the use of instruments, proper for measure-ing altitudes on these occasions, in such a climate, is attended with the difficulties already described in this Paper, it will, in all probability be admitted, that this mode of observation, is at least, calculated to diminish the errors necessarily arising from the use of instruments, under such circumstances.

It is, however, with diffidence that we submit the following tabulated results of the preceding observations, for compari-son with the various theories, which have from time to time been advanced by many eminent astronomers and mathema-ticians, to account for all the irregularities which have been noticed in the most careful observations on this important subject.

Recapitulation of the mean results, of the preceding Observations.

Stars Observed.	Apparent Altitude.	Barometer Corrected.	Temperat. Fahrenheit.	Obser ved Refraction.	No. of Obser.	Observer.
	° ′ ″	Inches.	°	′ ″		
Arcturus	7 38 0,52	29,749	—32,6	8 23,18	17	Lieut. Ross.
	7 37 8,14	29,786	—32,0	8 35,07	21	Lieut. Foster.
	7 35 18,43	29,805	—27,3	8 36,36	37	Lieut. Foster.
	7 31 38,62	29,791	—23,58	8 23,95	34	Capt. Parry.
α Aquilæ	4 40 38,0	29,785	—33,37	12 48,17	10	Lieut. Ross.
	4 39 31,5	29,742	—31,1	13 4,73	23	Lieut. Foster.
	4 39 1,8	29,748	—30,85	12 51,4	15	Lieut. Ross.
	4 38 58,03	29,795	—31,8	13 4,72	24	Capt. Parry.
	4 37 41,08	29,689	—33,37	13 0,42	10	Lieut. Ross.
	4 36 32,08	29,808	—29,0	13 9,37	32	Lieut. Foster.
	4 36 3,88	29,712	—31,35	12 58,85	12	Lieut. Ross.
	4 32 32,34	29,761	—29,94	13 12,51	27	Capt. Parry.

The original register of the height of the mercury in the barometer, after being corrected for instrumental errors, has been brought up to the temperature of + 50° of Fahrenheit, in the observations by Captain Parry and Lieutenant Ross, but to + 48° only, in the observations by Lieutenant Foster.

Port Bowen, July 10th, 1825.

From the Press of
W. NICOL,
Cleveland-row, St, James's.